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March 2007

Agricultural Growth Linkages in Ethiopia:

Estimates using Fixed and Flexible Price Models

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Bingxin Yu, International Food Policy Research Institute

Development Strategy and Governance Division

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INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

2033 K Street, NW
Washington, DC 20006-1002 USA
Tel.: +1-202-862-5600
Fax: +1-202-467-4439
Email: ifpri@cgiar.org

www.ifpri.org

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Abstract

Accelerating growth and poverty reduction, and the ultimate achievement of structural transformation, are the critical policy challenges in present day Ethiopia. This paper examines relevant growth options in terms of their impact on overall growth and poverty reduction in the country. It deploys a fixed-price semi-input-output model and a flexible-price economy-wide multi-market model for that purpose. The paper finds that agricultural growth can induce higher overall growth and faster poverty reduction than non-agricultural growth, although the latter can also have large growth effects in some cases. Among sub-sectors within agriculture, staple crops have stronger growth linkages. Decomposition of these effects also reveals that consumption linkages are much stronger than production linkages, i.e., the impact of increased consumption demand due to growth (agricultural and non-agricultural) is much larger than that of the corresponding expansion in input demand. Moreover, non-agricultural sectors have to grow in order to match growing supply of agricultural products and increasing demand for non-agricultural products. Otherwise, falling relative prices of agricultural products may dampen the realized gains in growth and poverty reduction.

1. Introduction

All major economies of the world, even the richest, started out as primarily agrarian economies. Over time, economic development has stimulated a process of structural transformation during which broad-based productivity growth accompanied a shifting sectoral composition of economic activity. There is widespread agreement that the share of agriculture will fall during this transformation and that transfers of capital and labour from agriculture help fuel growth in the expanding industrial and service sectors of developing economies (Chenery and Syrquin 1975). Disagreements emerge, however, about whether policy makers can siphon resources from agriculture with impunity or whether prior investments in agricultural productivity are necessary to enable these resource transfers to take place without raising food prices, urban wage rates and choking off industrial development (Timmer 1988).

Early development strategists emphasized the importance of promoting industrialization first (Lewis 1954). Albert Hirschman's (1958) influential early writings advocated focusing development resources in lead industries with strong spillovers throughout the economy. His pro-industrial prescription rested on the supposedly feeble production linkages between agriculture and the rest of the economy. In his words, "agriculture certainly stands convicted on the count of its lack of direct stimulus to the setting up of new activities through linkage effects - the superiority of manufacturing in this respect is crushing" (Hirschman 1958). This view contributed to a common neglect of agriculture, particularly during the 1960's. Yet in spite of Hirschman's confident assertion, import-substituting industrialization strategies broadly failed to stimulate broad-based economic growth (Bruton 1990).

As a result, many development specialists have come to believe that early investments in agricultural productivity constitute a necessary precondition for overall economic growth. For without rising farm productivity, the transfer of labour and capital from agriculture will lead to falling agricultural output, rising food prices and growing poverty (Johnston and Mellor 1961). Indeed, apart from a handful of city states and small island countries such as Mauritius, the vast majority of large economies worldwide have initiated growth through agriculture. According to a recent review by Michael Lipton (2005), "Since 1700, virtually all instances worldwide of mass dollar poverty reduction began with a sharp rise in labour income due to higher productivity on small family farms."

Ethiopia's aims to follow this standard pattern of agriculture-led economic growth. The country has formally adopted Agriculture Development Led Industrialisation (ADLI) as a development strategy in 1994, with the aim of investing in agricultural productivity in order to stimulate farm output and incomes, thus generating growth for both farm inputs and consumer goods. This strategy has been justified because agriculture is the largest sector in terms of output and, particularly, employment and exports; the bulk of the poor live in the agriculture-centred rural areas; considerable gaps exist between rural and urban average levels across key dimensions of well-being including health and education; and there exists substantial potential to raise agricultural productivity via the widespread introduction of modern technology (MoFED, 2002). Strategic thinking on the role of agriculture in growth has somewhat evolved recently, with the explicit acknowledgement in the new Plan for Accelerated and Sustained Development to End Poverty (PASDEP) that with ADLI 'the overall growth performance has not yielded the hoped-for poverty-reduction results over the long-term' (PASDEP, 2005). Thus, the Plan articulates a more comprehensive strategy which focuses on commercialisation and intensification of agriculture, favours a geographically differentiated strategy, recognises the dangers of volatile economic growth and rapid population growth, and highlights the importance of the urban sector.

In the face of a broad strategy based on agricultural growth, there remain considerable specific policy choices that involve carefully considering the options as to: which sectors have larger prospective linkages; what is the growth and poverty-reduction potential of these sectors and constraints thereof; and which policy interventions are capable of unlocking the growth potential. In order to answer these questions, it is necessary to empirically identify which types of agricultural growth linkages are potentially available and to establish how large they are. The assessment needs to be disaggregated since the extent of these linkages varies across branches of the large and diverse agricultural sector. Finally, growth options need to be systematically linked with policy interventions such that the instruments of achieving the desired goals are ascertained. The types and scale of public investment are clearly vital, in this regard.

In light of the above, this paper applies both fixed price semi-input-output modelling and flexible price multi-market modelling to measure the potential income-generating power of agricultural growth linkages in Ethiopia and to contrast it with that from non-agricultural growth. The estimates and corresponding analysis use recent data and primarily rely on a newly constructed Social Accounting Matrix (SAM) for the economy as of 2001/02. Specifically, the analysis explores the implication of alternative growth patterns to overall growth, the level and distribution of income, and thus poverty reduction in Ethiopia. Since linkages can vary substantially across sectors, the paper focuses on the growth linkages emanating from key sub-sectors of agriculture (essentially, staples and exportables) and manufacturing.

The rest of the paper has five main parts. Parts 2-3 set the scene by considering the question of growth linkages broadly and highlighting the relevant structural features of the Ethiopian economy. Part 4 describes the semi-input-output approach and reports the findings of its application to Ethiopia, while Part 5 does the same for the economy-wide multi-market approach. Part 6 concludes.

2. Why Agricultural Growth Linkages Matter[1]

As agriculture grows, it stimulates series of economic linkages with the rest of the economy. The resulting demand linkages, which constitute the focus of this study, fall into two broad categories: production linkages, and consumption linkages.[2]

Production linkages include backward linkages – the input demands by farmers for farm equipment, pumps, fuel, fertilizer and repair services – as well as forward linkages from agriculture to non-farm processors of agricultural raw materials. In prosperous agricultural zones, these linkages prove substantial as pump suppliers, input dealers, grain traders, processing industries and transporters emerge to supply agricultural inputs and process and distribute farm output. Empirical work on these relationships has focused on measurement of input-output coefficients to establish the strength of the forward and backward supply linkages.

Consumption linkages include spending by farm families on locally produced consumer goods and services. Early work in Green Revolution India indicated that higher-income small farmers spent about half of their incremental farm income on non-farm goods and services as well as another third on perishable agricultural commodities such as milk, fruit and vegetables (Mellor and Lele 1971). Thus, consumption linkages from growing farm income can induce sizable second rounds of rural growth via increased consumer demand for non-agricultural goods and services as well as perishable, high-value farm commodities such as milk, meat and vegetables. In places like India, where many non-farm goods and services are produced by labour-intensive methods, the spending multipliers not only accelerate growth but also enhance the equity of agriculture-led growth.

Following an initial spurt in farm productivity and incomes, production and consumption linkages together induce second rounds of demand-led growth. Empirical evidence from around the developing world suggests that a $1 increase in agricultural income will generate an additional $0.30 to $0.80 income in rural non-farm economy. Linkages are even higher when consumption of urban-produced products is included. In Africa and Asia, consumption linkages typically account for over 80 percent total spending linkages.

This evidence contrasts with Hirschman's claim of feeble agricultural growth linkages (Hirschman (1958)). Where did Hirschman go wrong? He underestimated agricultural growth linkages in two very fundamental ways. As Johnston and Kilby (1975) originally pointed out, agricultural technology changed during the green revolution. The new high-yielding varieties demanded pumps, sprayers, fertilizer, cement, construction labour, and repair facilities from

[1] Although the discussion below focuses explicitly on agricultural growth and linkages thereof, the approach and concepts therein apply to growth in other sectors as well.

[2] It is important to emphasise that this study, and almost all studies of its kind, focus on demand linkages described in the following paragraphs. Aside from demand linkages, there are other inter-sectoral linkages in an economy. Briefly, these operate via saving and investment (private and public), labour flows, and transfers including taxes.

non-agricultural firms, thus generating substantial backward linkages. Furthermore, considerable milling, processing and distribution of agricultural produce took place in rural areas, thus generating important forward production linkages as well. The new agricultural technology fundamentally altered input-output relationships.

Still more important were the consumption linkages that Hirschman had ignored altogether. As Mellor and Lele (1973) originally pointed out, consumption linkages from growing farm income induce sizable second rounds of rural growth via increased consumer demand. Where new technology or investment in agriculture leads to increased income, farm families spend large increments of additional earnings on high-value processed foods and on consumer goods and services such as transport, education, health, construction and personal services.

Available evidence indicates, however, that demand linkages vary considerably across locations and farm technologies. As Table 1 indicates, they typically prove highest in Asia and lowest in Africa because of higher input linkages with Green Revolution Asian agriculture and because of higher income levels which lead to more rapid diversification of consumer spending into non-foods.

The accumulating evidence briefly noted in the previous paragraphs induced a shift in the policy prescriptions concerning sectoral and overall growth. Reversing the industry-first orthodoxy of the 1950's, the results of Adelman's (1984) classic study suggest that agricultural demand-led industrialization can generate superior growth and equity when contrasted with the alternative of export promoting industrialization strategies. Better identified and measured growth linkages thus led to the recognition of agriculture as a potentially powerful engine of economic growth.[3] The same evidence also revealed that this potential is neither present nor equally realizable everywhere.[4] Consequently, it became vital to consider two sets of policy relevant questions. Globally, it is necessary to answer, under what conditions agriculture can become a leading sector to induce faster growth, how does agriculture grow, and do government policies matter a lot to agricultural growth. Specific to each economy, it is indispensable to establish the size of potential agricultural growth linkages and the extent to which it is possible to realize them. This paper attempts to accomplish the former with respect to Ethiopia.

Table 1: Agricultural Growth Linkages: International Evidence

		Additional Income Growth			**Source of Linkages (%)**	
	Initial Agricultural Income Growth	*Other Agriculture*	*Non-farm Activities*	*Total*	*Consumption*	*Production*
Asia	1.00	0.06	0.58	0.64	81.00	19.00
Africa	1.00	0.17	0.30	0.47	87.00	13.00
Latin America	1.00	0.05	0.21	0.26	42.00	58.00

Source: Haggblade and Hazell (1989).

[3] Prominent writers such as Irma Adelman, Peter Hazell, Peter Kilby, Bruce Johnston, Uma Lele, Michael Lipton and John Mellor highlight the potential power of agriculture-led growth strategies, particularly in the early stages of economic development.

[4] A good summary of the relevant issues and evidence can be found in Sarris (January 2001).

3. Structure of the Ethiopian Economy

A key message from the previous section is that production and consumption patterns play a crucial role in determining the direction and importance of growth linkages. Accordingly, this section broadly outlines the structure of the Ethiopian economy in order to provide the background and context of the linkages analysis of subsequent sections.

Data

Most of the data for the analysis is extracted from the 2001/02 Ethiopian SAM. The 2001/02 Ethiopian SAM is a 63x63 matrix and contains an account for each of twenty production activities, five factors of production, twenty-five commodities, transactions costs, three household groupings, three enterprise types, recurrent government, three types of public investment, savings/investments of institutions other than the government, and the rest of the world.[5] The details of the structure of the SAM are presented in Table A1 in the annex. As can be surmised from that table, the SAM captures the diversity in production activities and the interdependencies among the various sectors and institutions that characterise the Ethiopian economy.

Production and Incomes

In order to measure the interactions between agriculture and other sectors of the economy, it is necessary to have an up-to-date measurement of production linkages among sectors as well as links from various production activities to household incomes. Both of these elements, the input-output relationships (Table 3) and functional distribution of income (Table A2) are summarized in the social accounting matrix for 2001/02, constructed for this purpose.

Table 2: Structure of the Ethiopian Economy

	Agriculture			Manufacturing		Mining, Construction, Utilities	Services	GDP at Factor Cost
	Crops	*Livestock*	*Others*	*Large*	*Small*			
Value-added								
Level (million Birr)	12642	8073	3761	2213	1181	4659	27681	60210.9
Share (%)	21.0	13.4	6.2	3.7	2.0	7.7	46.0	100.0
Export earnings								
Level (million Birr)		2711		852		301	4420	
Share (%)		32.7		10.3		3.6	53.4	
Share in Merchandise Export Earnings (%)		70.2		22.1		7.78		

Source: Ethiopian SAM 2001/02.

[5] Choosing the year for which a SAM is to be built is one of the first key tasks. The year selected should ideally be a 'normal' year. It is not always easy to follow this rule, partly because what is 'normal' is relative. With this caveat, in the present case, the year 2001/02 was chosen because it is the most 'normal' recent year. It also has the additional attraction of being the year covered by the Ethiopian Agricultural Sample Enumeration (EASE) survey.

Agriculture dominates the Ethiopian economy, accounting for 80 percent of national employment, 41 percent of gross domestic product (GDP) and 33 percent of total exports or 70 percent of merchandise exports (Table 2).[6] More than 80 percent of these agricultural output and value-added (amounting to more than a quarter and a third of national output and value-added, respectively) is generated by subsistence farming.[7] More interestingly, subsistence livestock production accounts for close to 40 percent of agricultural output and a third of value-added.

In comparison, the small industrial sector produces only 14 percent of GDP, the top three industrial sub-sectors being construction, large-scale manufacturing, and utilities. Surprisingly, the small capacity in industry, particularly in large/medium manufacturing, is not utilised fully. Capacity utilisation in large/medium manufacturing is so low that actual output represented 48 percent of annual capacity in 2001/2002 (CSA (October, 2003b)).[8] This contrasts with the substantial importation of manufactured goods such as textiles and leather products.

Another striking feature of the Ethiopian economy is the size of its services sector. The share of services in national GDP is a few percentage points higher than two-fifth - much higher than what is appears to be consistent with the country's level of development.[9]

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[6] The employment figure is obtained from the labour force survey CSA (November, 1999).

[7] Output and value-added shares reported for agriculture in this section are out of output and value-added in 'agriculture, forestry, and fishing'.

[8] The rate of capacity utilisation displays considerable variation around this average rate. For further details see CSA (October, 2003b). Furthermore, low capacity utilisation is not unique to 2001/02. In 2003/04 only 48 percent and 66 percent production capacity was on actually used by the private and public firms belonging to the sector, respectively (CSA (October, 2003)). Indeed, low capacity utilisation is a perennial problem in manufacturing. During 1997/98-2003/04 period, private manufacturing enterprise could, on average, use only 34 percent of their full capacity. The corresponding rate in public manufacturing was 55 percent.

[9] A note on the size of the service sector. Using data from the World Bank and the OECD, Easterly et al (1994) attempt to develop an international norm for the appropriate size of services at different levels of development. They suggest that service sector shares of 50 per cent and above in GDP are appropriate for countries in the middle and upper-income countries. This implies that for low-income developing countries the size of the service sector should be lower, much lower for very poor countries like Ethiopia, than this level. This general understanding is corroborated by the share of services in the GDP in many developing countries (World Bank (2006)). Similarly, the regression results of Kongsamut, Rebelo and Xie (1999) imply that the GDP share of the services sector in Ethiopia corresponds to per capita GDP of close to US$4000 - a level many times over the per capita GDP of Ethiopia in 2001/02.

Table 3: Input Demand in Ethiopian Agriculture and Manufacturing

Shares of output (%)	Crops		Livestock	Manufacturing					
				Food		Textile and Leather		Other Manufacturing	
	Subsistence	*Modern*	*Subsistence*	*Large*	*Small*	*Large*	*Small*	*Large*	*Small*
Input source									
Agriculture	9.1	5.6	30.8	23.3	8.0	35.1	0.0	1.5	0.5
Industry	4.0	13.2	0.0	24.3	48.9	38.3	46.5	56.7	42.1
Services	0.0	0.0	0.0	2.2	6.9	0.8	11.0	4.0	2.8
Total Inputs	*13.2*	*18.8*	*30.8*	*49.8*	*63.8*	*74.1*	*57.5*	*62.3*	*45.5*
Value-added	86.8	81.2	69.2	32.1	36.1	17.7	42.5	27.0	54.3
Indirect taxes	0.0	0.0	0.0	18.1	0.1	8.2	0.0	10.7	0.2
Total	*86.8*	*81.2*	*69.2*	*50.2*	*36.2*	*25.9*	*42.5*	*37.7*	*54.5*
Total Gross Output	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Share of Imports in raw materials (%)	4.0	13.2		*27.6*		*23.8*		*74.3*	

Source: Ethiopian SAM 2001/02.
Notes: Imported inputs in agricultural essentially fertilisers.

Demands

By far the largest two components of domestic demand are household consumption and intermediate consumption (Table A3 in the annex). Household consumption (44 percent) constitutes the largest component of domestic demand, followed by intermediate demand (33 percent) and investment (13 percent). Not surprisingly, the share of household consumption is much higher (70 percent) in domestic demand for agricultural commodities. In contrast, intermediate consumption dominates (41 percent) domestic demand for industrial commodities.

These demands are covered by domestic production and imports, with the latter accounting for 17 percent. The share of imports reaches a third with respect to the demand for industrial goods, and is much higher for petroleum products, chemicals, and machinery and equipment. Indeed, industrial imports make up close to 75 percent of total imports. [10] That the largest fraction of domestic industrial demand is for intermediate consumption and that imports provide for a third of this demand means that access to these commodities is likely to be a binding constraint to economic growth. On the other hand, it indicates to considerable room for import substitution – an opportunity.

Despite its large size and expected comparative advantage, the agricultural sector provide only about a quarter of intermediate inputs and most of this to itself (Table 3). The sector's demand for inputs originating in other sectors is also very small. Indeed, the rather limited use of modern inputs

[10] It is noteworthy that 13% and 28% of the demand for cereals and textile/leather products is met by imports, respectively. Food aid makes up almost all of cereal imports.

constitutes one of the sources of low productivity in the sector. Comparatively, industrial goods represent close to half of intermediate consumption, but the bulk of this are imported.[11]

Consumption

The SAM provides more details about household consumption. However, since it summarizes current spending patterns, its column coefficients represent average budget shares. But incremental household spending typically differs from that initial average. As a result marginal budget shares are more realistic projectors of consumption spending as income grows. Wamisho and Yu (2006) describes how these marginal budget shares were estimated using household expenditure data from 1999/2000, while Table A4 summarizes the key resulting parameters used in the linkages analysis.

As income increases, the share of food expenditure in total expenditure drops steadily. Consumption shares decrease with increased income for most food items, with the exception of teff and processed agricultural products. When disposable incomes increase, households tend to allocate more income to industrial goods and service. This is especially the case for private service sector (including hospitality, recreation, entertainment and personal services), and average expenditure on private services surges fourfold from the lowest to the highest income quintile in rural areas.

Marginal propensity to consume (MPC) decreases across income level for most commodities except for processed agricultural products in rural and service sector in urban areas. However, despite declining marginal propensity to consume in staple food across income, the absolute level of consumption exhibits a strong upward trend due to significant income gaps. Thus, it is observed that absolute level of demand for most staple foods increases with income growth, and the relative increase is more manifest among poor households.

Briefly, agriculture figures prominently in the Ethiopian economy, especially in employment and exports; the small manufacturing sector imports a lot of its inputs and appears to be uncompetitive; and there is a large and growing services sector. Moreover, household consumption is dominated by food, though manufactures and services grow in importance at higher incomes. On the other hand, inter-activity domestic input demands are not very large while imports form a considerable fraction of input demand within manufacturing. Indeed, the dominant subsistence farming sector's use of modern inputs is so limited that it is identified as a key bottleneck to further growth in farm productivity. Finally, manufacturing production capacity is commonly not utilised in full.

The pattern of potential growth linkages in the Ethiopia economy would reflect its key features briefly noted above. For instance, limited inter-industry demands for domestic inputs imply

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[11] It is rather surprising that small-scale food processing has a larger intermediate input use as a fraction of output than large-scale food processing. The dominance of grain milling within the former explains the outcome. Relative to their size, most small grain mills use considerable amounts of electricity obtained from the national grid or self-produced via diesel generators. This amounts more than half of intermediate consumption, while the corresponding level in large-scale food processing is about a quarter.

that production linkages are likely to be weak. In contrast, the prominence of consumption in total expenditure indicates to the possibility of large consumption linkages. Still another example is the observed presences of considerable unused capacity in manufacturing - it means that, in principle, the sector can meet some of the growth-induced expansion in demand. In short, the direction and size of the growth linkages reported below should be interpreted in light of such structural features of the Ethiopian economy.

4. Analysis of Growth Linkages in the Ethiopian Economy Using a Semi-Input- Output Model

A variety of economic models are available for measuring agricultural growth linkages. The following analysis applies a fixed-price semi-output model, while subsequent dynamic analysis supplements this with a recursive price-endogenous model in the next section.

A Note on the Fixed Price Models

Fixed Price Input-Output Models

Studies of growth linkages most commonly apply some variant of the linear input-output (IO) model. In its most basic form, the input-output model uses fixed IO coefficients and assumes fixed prices and perfectly elastic supply in all sectors. With perfectly elastic supply, any increase in demand leads only to higher output, with no change in price. Total supply in each sector (Z) is modelled as the sum inter-industry input demand (AZ) and final demand (F), where final demand includes consumption by households (βY) and exogenous sources of demand such as exports (E). Income (Y) is related to production through a fixed value added share (v) in gross commodity output (Z).

$$\begin{aligned} Z &= AZ + F \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (1) \\ &= AZ + \beta Y + E \\ &= AZ + \beta v Z + E \end{aligned}$$

Since supply is assumed to be perfectly elastic in all sectors[12], total output and incomes are determined by the level of exogenous demand (E) and a matrix of multipliers (C).

$$Z = (I - C)^{-1} E \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (2)$$

Perfectly elastic supply in all sectors is, of course, an unrealistic assumption in many developing countries, particularly for some sectors. Given high rates of seasonal labour underemployment, typically low capital requirements and substantial rates of reported excess capacity in many rural non-farm businesses, a highly elastic supply of rural non-farm goods and services is frequently an appropriate assumption.[13] In contrast, shortages of skilled labour, foreign exchange, and fixed capital frequently constrain output in the formal industrial sector. Likewise in agriculture,

[12]As Bigsten and Collier (1995) and Haggblade, Hammer and Hazell (1991) note, the existence of a real multiplier hinges on the existence of slack resources which can be pulled into productive activity.

[13]Bagachwa (1981), Liedholm and Chuta (1976) and Steel (1977) report rates of excess capacity between 33 percent and 60 percent for the countries of Tanzania, Sierra Leone and Ghana. See Bagachwa and Stewart (1992) for a detailed summary.

seasonal labour bottlenecks, land availability, soil fertility, input supply, marketing infrastructure and moisture constraints frequently limit supply responses.

Even so, some analysts suggest that agricultural supply elasticities may be high, at least over a certain range (Delgado et al. 1998; Thorbecke 1994). Anecdotal reports of piles of rotting fruit, unable to find their way to market, and excess bags of grain unevacuated from specific remote regions bolster these claims in some, limited circumstance. Yet apart from these episodic special cases, the overwhelming bulk of empirical evidence points to a low aggregate supply response in agriculture (Binswanger 1989). If farmers in the developing world could, in fact, increase crop output in unlimited amounts, agriculture would indeed represent a powerful engine of economic growth, for both malnutrition and poverty would vanish overnight as hungry farmers availed themselves of this perfectly elastic cornucopia.

By ignoring supply constraints altogether, unconstrained input-output and SAM multiplier models exaggerate the size of the inter-sectoral linkages. Given that over half of the reported indirect effects in these unconstrained models come from demand-induced growth in food grains and other allegedly elastically supplied agricultural commodities, this questionable assumption biases anticipated indirect income gains substantially upwards. Side-by-side comparison with alternative formulations suggests that the unconstrained input-output models overstate agricultural growth multipliers by a factor of two to ten (Haggblade, Hammer and Hazell 1991).

Fixed Price Semi-Input Output Models

To better simulate real-world supply rigidities, semi-input-output (SIO) models classify sectors into two groups, those that are supply-constrained (Z_1) and others that are perfectly elastic in supply (Z_2).[14] As described in equations (3) and (4), the SIO model permits output responses only in the supply responsive sectors (Z_2). Perfectly elastic supply ensures fixed prices for these (Z_2) goods. In the other group, of supply-constrained products (Z_1), perfect substitutability between domestic goods and imports guarantees that world prices will ensure fixed prices for these goods as well. For these models to produce a reasonable approximation of reality, the supply-constrained sectors must correspond to tradeable goods whose domestic supply remains fixed at the prevailing output price. In these supply-constrained sectors (Z_1), increases in domestic demand merely reduce net exports (E_1), which then become endogenous to the system and determined by the matrix of semi-input-output multipliers (C^*).

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[14] See Bell and Hazell (1980), Kuyvenhoven (1978) and Tinbergen (1966) for further discussion of the semi-input-output method. In cases where equations are specified for all accounts of a complete social accounting matrix, semi-input-output models are also termed "constrained SAM multiplier models".

$$Z_1 = A_1 Z + \beta_1 v_1 Z + E_1 \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (3)$$
$$Z_2 = A_2 Z + \beta_2 v_2 Z + E_2$$

$$E_1 = (I - C^*)^{-1} Z_1 \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots (4)$$
$$Z_2 = (I - C^*)^{-1} E_2$$

As social accounting matrices have grown in popularity, SAM-based multiplier estimates have emerged to complement and extend the early linkages work. In spite of sometimes different labels, the SAM-based multipliers are formally identical to the IO and SIO models. All require an input-output table to calculate the production linkages; all adopt fixed prices, fixed input-output coefficients and fixed marginal budget shares; all come in unconstrained and constrained versions. The SAMs themselves become convenient tools for summarizing the raw data and results. They also provide a basis for incorporating capital, trade and government accounts. Frequently, given their origin in poverty and income distribution analyses, the SAMs offer great detail on factor allocation and distribution of income across household groups. What many in the literature call "unconstrained SAM-based multipliers" are formally identical to the unconstrained I/O models. Similarly, the "constrained SAM-based multipliers" are formally identical to the SIO models (Haggblade, Hammer and Hazell (1991); Lewis and Thorbecke (1992)).

What does the SIO model reveal? SIO model assumes that a sector's output and associated incomes have increased due to a productivity gain or expansion in input use. Demand for inputs and consumer goods rise as a consequence. These will in turn induce growth in sectors where a local supply response is possible. The cycle continues until all related growth possibilities are exhausted. In this regard, it is important to note that the SIO analysis does not explain why or how the initial increase in a sector's output occurs or why certain sectors respond to this trigger while others do not.

A further step toward realism in modelling linkages involves endogenising prices and relaxing the assumption of fixed output of tradable goods and perfectly elastic supply of non-tradable goods. Part 3 examines dynamic growth paths using such a price-endogenous model.

As noted above, the SIO framework associates some commodities/activities with constrained/inelastic supply, i.e. supply that would not adjust to demand stimulus. Tradability, technological and/or resource constraints, and capacity utilisation condition the extent of such rigidities. In the present case, public administration, utilities, and all agricultural commodities, other than fruits, vegetables, livestock and livestock products, are deemed supply-constrained. Rigidities in crop supply largely stem from the predominance of rain-fed agriculture and land-related resource constraints. In contrast, the reported considerable unused capacity in most of manufacturing suggests the possibility of expanding supply without significant incremental costs.[15] Therefore, all manufacturing, mining and construction, and services (except public administration) are identified as supply-unconstrained.[16]

The impact of growth in the output of two staple crops (maize and teff), an export crop (coffee), livestock, and two manufactures (textiles, other manufactures) is examined under the conditions specified. The aim is to provide a contrasting analysis that can inform the dialogue on investment strategies in Ethiopia. More specifically, the results allow a comparison across three broad investment strategies for the country: growth in staple crops (maize and teff), growth in export crops (coffee) and growth in manufacturing. Differences in technology are also explored by positing 'traditional' and 'modern' technologies in crop production.[17]

Impact on Growth

Under the assumptions summarised above, a 1 Birr increase in maize output under traditional agricultural production will generate 1.97 Birr rise in total GDP. The analogous change in GDP are 2.18 Birr for teff, 3.45 Birr for coffee, 1.40 Birr for textiles, and 1.16 Birr for other manufactures (see Table A5).

The contrast between agricultural products and manufactures is marked. This difference arises primarily because of smaller value-added generated by the direct increase in manufacturing output. As a fraction of the gross value of output, material inputs used in manufacturing range from 46 percent in small-scale other manufacturing to 81 percent in large-scale textile production with an average of 65 percent. Value added, thus, comprises on average 36 percent of output only. By comparison, the value added in total output is much higher in the agricultural sub-sectors, accounting for 78 percent on average. Consequently, a 1 Birr increase in agricultural output produces a bigger direct impact on GDP – 0.61 Birr and 0.70 Birr, for maize and teff production, respectively. An identical expansion in textiles and other manufactures output can only generate, respectively, 0.12 Birr and 0.05 Birr direct increase in GDP.

The gap between the direct increase in GDP and the total change in GDP originate in the second and third round linkages, the input demand and consumption growth emanating from the injection of agricultural growth. Consumption linkages in particular are clearly important. They account for over half of total additional income created via growth in traditional agriculture with the exception of traditional coffee farming (Table A6, last row**)**. Coffee's lower consumption share in

[15] For instance, CSA survey data reveals that capacity utilisation within large/medium-scale manufacturing averaged just above 50 percent during 1997/98-2003/04. More tellingly, this rate of capacity utilisation varies very little across years.

[16] For comparative purposes, the SIO simulations were run for a more constrained scenario in which all agricultural commodities, all manufactures (except manufactured food, beverages, and tobacco), utilities, and public administration are supply-constrained.

[17] 'Traditional' technology corresponds with input-output configurations in subsistence crop production derived from the 2001/02 Ethiopian SAM, while 'modern' technology coincides with those prevailing in commercial farming.

linkages effect is explained by the fact that, as a major export crop, it is associated with substantial trading/processing and hence larger production linkages. On the other hand, manufacturing induces smaller production and consumption linkages though the former are larger due to stronger forward and backward linkages combined with much higher intermediate consumption.

In short, almost all sectors generate large linkages. But those induced by agricultural activities are larger, primarily because of larger initial value added (income) and consequently larger second round of consumer spending on local goods and services (i.e., input demand and consumption linkages additional to first round effects).

Impact on Incomes

Table A5 also reports the total change in income induced by growth and its distribution among the three household groups. A 1 Birr increase in maize output under traditional agricultural production will generate 1.32 Birr rise in total household income; while an equivalent change in traditional teff and coffee production will increase total household income by 1.48 Birr and 1.88 Birr, respectively. Growth in manufacturing output has much lower positive impact on household incomes.

In terms of the distribution of income across households, expansion of maize and teff production with traditional technology naturally benefits farm households most. The case of coffee is worth noting, in this regard. A substantial proportion of coffee output is exported and, partly due to that, very high transport and trade margins are associated with the crop. As a consequence, a relatively small fraction of the income gained from growth in coffee production accrues to farm households. Most of this income goes to wage earners and entrepreneurs.

With the farm households forming the bulk of the poor, the potential impact on income poverty is thus greatest with growth in staple crops production. A more direct measurement reported in Part 5 below supports this finding.

It is clear that technological change would be significant to the direction and extent of growth linkages. Accordingly, as part of examining the linkage effects, a simple simulation was conducted to assess this significance. The simulation identifies the input configuration in subsistence farming as representing 'traditional technology' while that in commercial farming as representing 'modern technology.' A comparison of outcomes respectively generated by assuming that all crops are produced using 'traditional' or 'modern' technology provide a rough way of exploring the effect of technological change. Table A5 reports the corresponding estimates.

By taking into account the linkage effect only (and ignoring the productivity growth-effect that often results in more efficient use of input), a shift from traditional to modern technology in staples (maize and teff) production will marginally reduce the gains in total household incomes from a same unit increase in the staple crop production since intermediate input use rises (see Table A5). More significantly, it modifies income distribution in favour of wage earners as wage labour substitutes for family labour due to the change in technology. While this outcome may underestimate the gains from technology change that is often embodied in the use of modern inputs, it raises an important concern in promoting the use of modern inputs. With the introduction of modern technology, intermediate inputs will account for a growing share of total production revenue. This, in turn, may possibly weaken the agricultural growth linkages by reducing farmers' direct income gains, per unit of output, and thus reducing subsequent spending on locally produced goods and services. This potentially lower growth linkage effect compounds the problem some observers have raised about high-input technology increasing smallholder reliance on input markets beyond their direct control.

In conclusion, growth in agriculture produces stronger linkages than growth in non-agriculture. The potential benefits of stimulating growth in agricultural production (albeit differentiated by products) are thus substantial. Nevertheless, the size of this potential as well as the extent of its realisation depends on a parallel expansion in non-agricultural sectors (particularly in those associated with growing input or consumption demand). Estimates obtained by varying the set of non-agricultural sectors assumed to be supply unconstrained show this dependence clearly.[18] Moreover, the estimates in the next part show this more directly. Finally, it is important to note that the assumptions underlying the SIO framework imply that the reported magnitude of growth linkages (attributed to agriculture or non-agriculture) are likely to be upper bounds of the potential gains. [19]

18 For instance, if all sectors are unconstrained and thus can respond to the demand stimulus fully, a 1 Birr increase in maize output under traditional agricultural production will generate 2.93 Birr rise in total GDP. The analogous change in GDP are 3.43 Birr for teff, 3.05 Birr for coffee, 3.45 Birr for livestock products, and 2.26 Birr for textiles. These increases are accompanied by greater gains in household incomes. The complete simulation results can be obtained from the authors upon request.

19 These, rather strong, assumptions are fixed prices and perfectly elastic supply response in some sectors.

5. Analysis of Growth Linkages in the Ethiopian Economy Using an Economy Wide Multimarket Model (EMM)

Ethiopia has an open economy. However, high transportation and other marketing costs, partly explained by considerable geographic distances and an inadequate road network, prevent world market prices from automatically translating into domestic prices. As a consequence, many commodity prices, especially those of agricultural products, are actually determined by supply and demand conditions in the domestic market. For these reasons, it is necessary to take into account for the interaction of prices and growth (the price effect) in analyzing agriculture-non-agriculture linkages. Accordingly, this section reports the findings of an economy wide multimarket (EMM) model, in which prices of most agricultural and non-agricultural products are endogenous variables.

A Note on the EMM Model

The EMM model[20] captures the detailed structure of Ethiopian agricultural sectors, while the non-agricultural economy has a similar structure as the SAM discussed above (i.e., it includes 10 aggregate sectors). The original EMM model was developed by Diao and Nin Pratt (2007) in which there were only two aggregated non-agricultural sectors and intermediate inputs were not taken into account. This model is extended and modified for this study in order to be consistent with the non-agricultural economy described by the SAM discussed above, while detail agricultural sectors are still kept as before. Specifically, there are 32 agricultural commodities or commodity groups (see Table A6 in the annex for a list of agricultural commodities/sectors included in the model). In contrast with the SAM that represents the national economy, both agricultural and non-agricultural production and consumption in the EMM model are further disaggregated into sub-national regions in order to capture the geographic heterogeneity of sectors and households. Limited by the data, the model captures totally 56 administrative zones and all supply and demand functions are defined at the zonal level.

The EMM model is based on neoclassical microeconomic theory. In the model, an aggregate producer represents a specific zone's production of a specific sector. There are a total of 2,352 (42 sub-sectors x 56 zones) such representative producers. Consistent with the setup of many other multimarket models, the supply function, rather than the production function, is used to capture each representative producer's response to market conditions. Specifically, the supply functions are derived under producer profit-maximization and based on the producer prices of all commodities (including

[20] While the CGE approach is preferable for economy wide analysis and more comparable with above SIO analysis, the EMM model is more disaggregated in both commodities and regions. Moreover, the growth-poverty linkages can also be analyzed using the model.

the prices for the 10 non-agricultural commodities). Risk and market imperfections are not taken into account and therefore do not affect producers' profit-maximization decision in the model.[21] In the crop sub-sectors, the supply functions have two components: (i) yield functions that are used to capture supply response to the own prices given farmland allocated to this crop; and (ii) land allocation functions that are functions of all prices and hence are responsive to changing profitability across crops given the total available land. The own-price elasticities employed in the yield functions are the combination of authors' estimates, assumptions and results drawn from other studies, while the cross price elasticities in the area functions are calibrated according to the share of each commodity in regional total production.

The production of major staple crops and livestock products involves a variety of technologies. For staple crops, modern inputs and their effects on crop productivity are captured through the identification of 15 different technologies, maize production, for example, incorporates four primary modern inputs—fertilizer, improved seeds, pesticide, and irrigation (individually or jointly)—and also includes production without modern inputs. While the model captures the average difference in crop yields across technologies, the marginal effect of increased use of an input for a given technology is not captured because input uses are not explicitly included in the supply function. The yield gaps for a specific crop among the 15 technologies are defined at the zonal level and are consistent, by zone, with data from the national agricultural sample surveys for 1997 and 2000. Data on irrigation was also available for cash crop production and hence was employed in supply functions for those crops.

For livestock, the model captures the productivity difference between traditional and modern technologies. For example, three types of cattle are raised to produce beef: draught animals, from which beef is a by-product; beef animals, using traditional technology; and beef stock, using improved technology. The productivity (yield) gaps resulting from the use of different types of technologies in animal production are reflected in the supply function. Moreover, the supply function also captures the difference in feed use between traditional and modern technologies. Livestock production under modern technology requires feed grain, while under traditional production it assumes feeding via grazing only. The feed-grain demand function is therefore defined only for improved technology, and is a function of grain crop prices. Different technologies are similarly defined for dairy, poultry, and sheep and goats.

Demand functions are also disaggregated to the zonal level on per capita (rural or urban) basis. A representative consumer's demand for each consumption good is derived from maximizing a Stone-Geary utility function and the subsistence level of consumption is calibrated to the first quintile households' consumption (rural and urban separately). Data used to calibrate the demand functions

[21] Weather risk is high in many areas of the country as evidenced by frequent drought and very limited irrigation. While such risk is not explicitly modelled, a drought scenario is designed and discussion about this scenario can be found in Diao et al. (2005).

are from the 1999/2000 Household Income, Consumption, and Expenditure Survey (HICES [CSA 2000]). Both income and price elasticities for any specific commodity vary across zone due to different consumption patterns and income levels (see Wamisho and Yu (2006) for the estimation of income and price elasticities). Such differences not only imply that the aggregate effect of consumers' market responses is often non-linear and much more complicated than that in the case where demand is defined at the national level, but also indicate the possible differential effect on poverty reduction with similar income increases. These are a focus of model simulations which will be discussed later.

Distinguished from most multimarket models that are usually partial equilibrium in nature, the per capita income at the zonal-level is an endogenous variable in the EMM model. It is determined by the zonal-level value added divided by population, rural and urban, respectively. Because of such setup, the model has a general equilibrium nature, which allows production and consumption decisions to be linked at the zonal level. Similar as a CGE model, intermediate inputs are explicitly included in the model through fixed input-output relationship with sector's production. The IO coefficients are drawn from the SAM developed in Taffesse, Belay, and Wamisho (2006) for the purpose of growth linkages analysis. The aggregate of agricultural production value added equals agricultural GDP (henceforth, AgGDP), and the sum-total of agricultural and non-agricultural value added equals national GDP.[22] Both AgGDP and GDP are endogenous in the model.

As the name of the model suggests, a multiple market structure is specified. It is further assumed that there is perfect substitution between domestically and internationally produced commodities. However, transportation and other market costs distinguish trade in the domestic market from imports and exports. For example, while imported maize is assumed to be perfectly substitutable with domestically produced maize in consumers' demand functions, maize may still not be profitable to import if its domestic price is lower than the import parity price less any transactions costs. Maize imports can only occur when domestic demand for maize grows faster than domestic supply and the local market price rises significantly. A similar situation applies to exported commodities. Even though certain horticultural products are exportable, if domestic production is not competitive in international markets, either due to low productivity or high transactions costs, then exports will not be profitable. Only when domestic producer prices plus transactions costs are lower than the export parity price of the same product does it become profitable to export.

The model does not capture bilateral trade flows across sub-national regions, although it does identify sub-national regions as being food surplus or deficit by comparing regional level demand and supply for total food commodities. While producers and consumers in different regions operate in the same national markets for specific commodities, prices can vary across regions due to differences in transportation and market costs. For example, domestic marketing margins are defined at the regional

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[22] The model includes neither government expenditure, nor any government tax or other policy instruments.

level according to the distance to Addis Ababa, which represents the central market for the country.[23] For a food surplus region, food crop prices faced by local producers are equal to the prices in the central market subtracting marketing margins, while for a food deficit region local prices are higher than those in the central market due to marketing margins.

The EMM model thus characterised is deployed to explore growth linkages and impact on poverty reduction. The initial stimulus to growth is introduced as an exogenous productivity growth. Moreover, a 'baseline' and four different productivity growth scenarios are considered. To make the resulting linkage estimates comparable, the impact of sectoral size and growth potential need to be take into account. Assuming similar growth rates at the sub-sector level, greater economywide growth will be generated by the larger sub-sectors, in turn producing a (generally) larger effect on poverty. On the other hand, small sub-sectors have greater capacity to grow rapidly and require the investment of fewer resources to do so. Thus, in determining whether a sub-sector will ultimately drive growth, both the linkage effects on the economy and poverty as well as the growth potential (determined by supply and demand factors) must be considered. In order to ensure comparable quantitative measurement across the agricultural sub-sectors modelled, those exhibiting similar total GDP growth but different productivity growth were examined to assess the growth effect of each on overall economic growth and poverty reduction.

To analyze the growth-poverty effect, the nationally-defined poverty line is adopted in the model rather than using the World Bank's 'a-dollar-a-day' measure. National poverty lines are typically measured by household total expenditure, since household income is often significantly underreported in developing countries. The household level expenditure data from HICES is used to develop a micro-simulation model to capture detailed household consumption patterns. This micro-simulation model is linked with the EMM model for calculating poverty rates at the regional or national level. The calculation of poverty lines and fraction of populations below the poverty lines in the simulations and other detailed mathematical descriptions of the model can be found in Diao et al. (2005).

The following sections report a number of key results concerning impact on growth and poverty.

Impact on Growth

A large number of previous studies have concluded that agriculture, especially food crops, have strong growth linkages and multiplier effects; that is, increased agricultural (or food crop) production would generate a disproportionately large increase in the country's total GDP, through increased demand for inputs, and more importantly, through increased consumption demand as a

[23] The model cannot capture commodity chains that often link producers and consumers directly. Recent market development in Ethiopia shows certain new trends in grain trade flows and Addis Ababa is not necessarily a central market for some trade flows. The model, however, has to simplify the trade flow by ignoring such new trends.

result of higher agricultural incomes.[24] As the SIO model of the previous section, the EMM model is used to derive sectoral-level growth multipliers, deriving from total factor productivity (TFP) shocks in corresponding agricultural sub-sectors.

'Baseline'

Prior to the comparative analysis of agriculture-non-agriculture growth linkages, the EMM model is employed to assess a business-as-usual scenario (also known as the "baseline") in which the economy is assumed to grow following its current trajectory through 2015 (and 2003 is the base-year used in the model). The business-as-usual growth path is based on average agricultural and non-agricultural growth trends for 1995–2004, during which time about 70 percent and 50 percent of the increase in total crop production and cereal production, respectively, resulted from area expansion. Over the same period, the cereal production growth rate was 2.9 percent per year – 0.4 percent higher than the 2.5 percent population growth rate – and the growth rates of total staple crop and cereal yields were about 0.8 and 1.5 percent per year, respectively. Under the business-as-usual scenario to 2015, and based on livestock production growth of 4.1 percent per year and non-agricultural growth of 5.3 percent per year, GDP is projected to increase at 4.5 percent per year, and AgGDP at 3.7 percent per year.

On this basis, the livelihood of the majority of rural Ethiopians will not get significantly improved by 2015. The national poverty rate will fall to 32.1 percent by 2015, from the high 2003 level of 44.4 percent. Given 2.5 percent yearly population growth during 2003–15, the decline in the number of people living below the poverty line will only occur in the urban areas, while the number of the poor in the rural areas is estimated to increase by 83 thousand by 2015.

Staples Production has Stronger Growth Linkages over Time than Export-Oriented Production

It is thus clear from the business-as-usual scenario that without additional growth in both agriculture and non-agriculture, it will be impossible for the country to meet the first MDG of halving the poverty rate by 2015. On the other hand, achieving the objectives of halving poverty requires a greater understanding of which sub-sectors can best drive the economywide growth and cut poverty faster. Hence, this section focuses on an evaluation of two broad agricultural sub-sectors in terms of the country's growth and poverty reduction strategy. The two sub-sectors are staples (cereals, root crops, pulses, oilseeds and livestock) and exportables (coffee, selected fruits and vegetables, cotton, chat, sesame seed, sugar, and other horticultural products). Specifically, these sub-sectors' contribution is assessed by exogenously increasing the productivity growth rate of one sub-sector, while maintaining the growth of the others at their baseline levels.

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[24] See Bell and Hazell (1980) for an early methodological discussion of alternative multiplier models used in growth linkage analysis, and the discussion of Haggblade, Hammer, and Hazell (1991) on the improvement in the multiplier models with limited price endogeneity.

With 86 percent of AgGDP and 44 percent of GDP, staples represent the largest agricultural sub-sector in terms of value-added. In contrast, the export sub-sector constitutes quite small shares accounting for about 10 percent of AgGDP and 5 percent of total GDP. Thus, the simulated additional annual growth for cereals' productivity was first determined, at 1.5 percent, which implies 2.2 percent additional annual growth in livestock. In total, additional 1.8 percent of annual growth rate is obtained for the aggregated staple food sector (staple crops and livestock, Table 4). With such growth rate in the staple sector, total GDP will grow at 5.5 percent (partly through strong linkage effects on the non-agricultural sector that will be discussed later). In order to produce the same 5.5 percent of GDP growth rate, the agricultural exports sector needs to grow at 15.6 percent, with additional 12.5 percent of annual growth compared with the base-run (Table 4).

Table 4: Agricultural and Non-agricultural Growth Rate in the Simulations

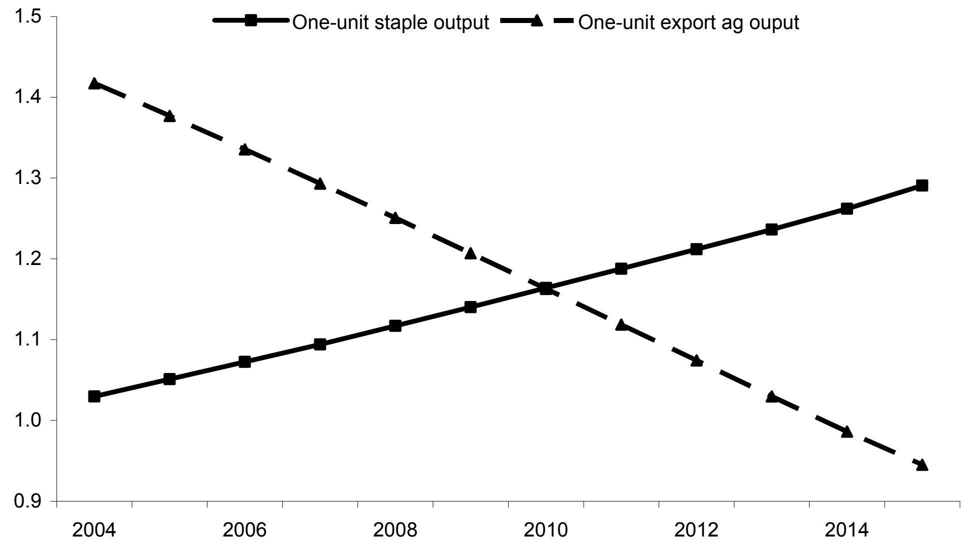
Growth Rate	Base-run	Staple crop led growth	Export crop led growth	Agricutlure led growth	Nonagriculture led growth
GDP growth rate	4.5	5.5	5.5	5.5	5.5
Ag GDP growth rate	3.7	4.1	5.7	4.5	4.2
NAg GDP growth rate	5.3	6.8	5.4	6.4	6.7
Total staple crop and livestock growth rate	3.1	4.9	3.0	4.3	3.2
Cereal output growth rate	2.9	4.5	2.9	4.2	3.0
Livestock output growth rate	4.1	6.4	4.0	5.2	4.2
Total export crop growth rate	3.1	2.7	15.6	7.7	3.0
Nontraditional export crop growth rate	4.0	3.7	15.0	8.0	4.0
Nontraditional exports growth rate	8.0	4.8	31.2	18.3	6.4

Source: Authors calculation from the EMM model results

To make the impacts more clearly comparable growth multipliers are used. The multipliers are defined as the total increase in real GDP divided by the increase in the shocked sector's total output, both measured at the initial (base-year) level of prices. The resulting multipliers derived using an economy wide and endogenous price models are in general relatively smaller than the standard fixed-price multipliers.[25] Our model's simulation results show that the staple sector's growth multipliers are consistently greater than one and increase overtime (Figure 1). These results imply that one unit (not one percent) increase in staple production will generate more than one unit of increase in total GDP. Moreover, such growth linkages become stronger over time. For example, one unit of increase in staple production can have 1.03 – 1.12 units of increase in total GDP in the first five years in the simulation, while the same one unit of increase in staple production will generate 1.29 units of GDP by 2015. On the other hand, the linkages from agricultural export sector to total GDP is strong only in the initial five years, while the linkages become weaker overtime, and the growth multipliers fall to below one by 2015.

[25] See Dorosh and Haggblade (2003) for a comparison of CGE and fixed-price multipliers for several Sub-Saharan African countries.

Figure 1: GDP Growth Multipliers in Staple and Export Agricultural Growth Scenarios (Both with 5.5% GDP annual growth)



Source: Authors calculation from the EMM model results

The strong growth linkage effect from staples sector to total GDP is mainly due to induced growth in the non-agricultural sector. In the scenario in which growth is driven by productivity increases in the staple sector, the non-agricultural GDP's annual growth rises to 6.76 percent, from its 5.26 percent in the base run. The additional 1.5 percentage points of annual growth is solely driven by growth in staple sector, as there is no additional exogenous growth shock imposed on the non-agricultural sector in this scenario. On the other hand, if the economy wide growth is driven by additional growth in agricultural export sector, the annual growth rate in the non-agricultural sector rises only to 5.36 percent, with additional 0.1 percentage points of annual growth compared with the base run.

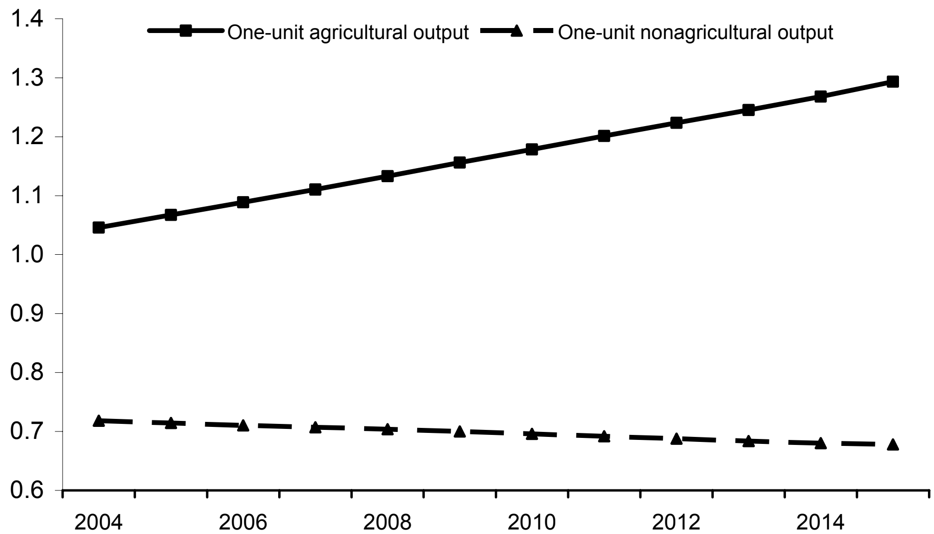
Agricultural Growth Stimulates Non-agricultural Growth

Two more scenarios are run to further analyze the linkages between agricultural and non-agricultural growth. In Scenario 3, it is assumed that an additional productivity growth shock occur withinthe agricultural sector only, while in Scenario 4, a similar productivity growth shock is imposed on the non-agricultural sector only. Again, the target is a 5.5 percent annual growth rate of GDP in both scenarios. To generate such growth in total GDP (by taking into account the linkage effects), grain production grows at 4.5 percent, with 1.5 percentage points of additional annual growth from the base run, and livestock grows at 4.7 percent, additional 1.1 percentage points of annual growth. This results in a staple sector growth of 4.3 percent, an additional 1.2 percentage points of annual growth. A relatively higher growth rate (7.7 percent) is needed for the export agriculture with 4.5 percent of additional annual growth. This results in total agricultural output (not AgGDP) to grow at

4.7 percent per year, instead of the 3.1 percent in the base run, and thus leading to a 1.6 percent of additional annual growth.

Growth in agriculture significantly stimulates the non-agricultural sector's growth. Measured by total non-agricultural GDP, the annual growth rises to 6.42 percent, instead of 5.26 percent in the base-run. The additional 1.2 percentage points of non-agricultural annual growth are thus induced by the growth in agriculture. Calculated GDP growth multipliers are 1.05 – 1.13 in the first five years and increase to 1.29 by 2015 in this scenario (Figure 2). That is to say, a one unit increase in total agricultural output (measured at the base-year's prices) can generate more than one unit of total GDP and its impact will reach 1.29 units of GDP by 2015.

Figure 2: GDP Growth Multipliers in Agriculture-led and Non-agricultural-led Growth Scenarios (both with 5.5% GDP annual growth)



Source: Authors calculation from the EMM model results

In Scenario 4 the initial exogenous increase in productivity is assumed to happen in the non-agricultural sector only. The non-agricultural sector grows by 5.26 percent in the base run. In order to induce total GDP to grow at 5.5 percent annually, the sector's annual growth rises to 6.76 percent, with 1.5 percentage points of additional annual growth. However, the non-agricultural sector can stimulate the growth in the agricultural sector only slightly. Agricultural GDP's growth rate rises to 4.15 percent, instead of 3.70 percent in the base run. The calculated GDP growth multipliers in this scenario are less than one, 0.72 in 2004 and 0.68 in 2015. In other words, a one unit increase in non-agricultural real output (not non-agricultural GDP) can only generate a less than one unit increase in total GDP (see Figure 2 for the growth multiplier comparison between the two scenarios).

Demand Linkages are Important for Non-agricultural Growth

Strong demand linkages explain why faster agricultural growth, especially of food production, has such strong growth linkage effect on the non-agricultural sector. Empirical studies show that agriculture-demand linkages are the dominant factor to stimulate non-agricultural growth in low-income countries. For low-income countries, a majority of the population lives in the rural areas and mainly depends on agriculture for its livelihood. This has two implications for the overall growth in the economy. First, it implies that it is unlikely to have any broad-based growth without agriculture. Growth in agriculture, especially in those sub-sectors in which a majority of farmers is engaged, can become an engine strong enough to generate overall economic growth. This is the direct effect of agricultural growth on the economy-wide growth. Second, it implies that rural demand is the dominant factor to provide enough market opportunities for both industrial products and services produced in the economy. Increased farm income has to be spent on both agricultural and non-agricultural commodities, including services. Income elasticity of demand for the non-agricultural commodities and services is often greater than that for the agricultural goods, which implies that farmer will spend more of the additional income on non-agricultural consumption. This is the indirect effect – through demand linkages – of agriculture on the overall economic growth.

With more than 85 percent of population living in the rural areas, rural demand is the major component of total demand in the Ethiopian domestic market. Even though per capita rural income is 40 percent lower than the urban income on average and each rural individual's non-agricultural consumption is 60 percent below the level for an average urban consumer, because of the dominant size of rural population in the country, more than 70 percent of non-agricultural products and services are actually consumed by rural households.[26] As many poor rural households can barely have additional cash income left after meeting basic food consumption, increased income, especially cash income, will be spent disproportionately more on non-agricultural consumption. The estimated marginal propensity to consume shows that for each one Birr of additional income, rural household would spend 0.6 Birr on non-agricultural consumption, though the average budget share of non-agricultural consumption is about 30 percent. Moreover, the marginal budget share (MBS) of non-agricultural spending is higher among the low income groups than that for the higher income groups among the rural population. For example, the MBS for the non-agricultural products and services is as high as 0.74 for the lowest income quintile in the rural areas. This share declines as income increases, and it is 0.47 for the highest income quintile. Agriculture is the main income source for many poor rural households. Given their extremely low level of non-agricultural consumption, with increased income generated from agricultural growth, rural households will provide steady growing market opportunities for the country's non-agricultural sector.

26 Calculated from HICES for the data of 1999/00

Impact on Poverty

It is widely anticipated that Ethiopia is unlikely to meet the first MDG of halving poverty by 2015 unless the country's growth performance improves dramatically. Ethiopia needs to not only accelerate the level of growth, but also find ways to enhance the 'pro-poorness' of growth. In other words, identify the kind or composition of growth that is most effective at reducing poverty. In this regard, it is necessary to consider the relative importance of agriculture and industry in helping the country achieve its development objective of significantly reducing poverty.

The EMM model is thus used to examine how differences in the pattern of growth in the country influence the rate of poverty reduction. More specifically, using the same four scenarios discussed above, the growth-poverty linkages is also analysed by comparing the effectiveness of additional growth in reducing poverty under different growth assumptions. To make the results comparable, poverty-growth elasticities are calculated for each of the four scenarios.[27] Table 5 shows that the poverty-growth elasticity is larger when additional growth is driven by agriculture rather than non-agriculture. A one percent annual increase in per capita GDP driven by agricultural-led growth leads to 1.9 percent reduction in the poverty headcount rate per year. By contrast, a similar increase in per capita GDP driven by non-agriculture leads to only 1.1 percent fall in the poverty rate. These disparities in poverty-growth elasticities can translate into different reductions in the poverty headcount over time. For example, with 5.5 percent of GDP growth in both scenarios, the poverty headcount falls to 25 percent in the agriculture-led growth scenario, compared with 28 percent in the non-agriculture-led growth scenario (Figure 3). Given its larger impact on poverty, agricultural-led growth in Ethiopia lifts an additional 2.9 million rural people out of poverty compared to non-agricultural-led growth. Though in the non-agriculture-led growth urban poverty population reduces more than that in the agriculture-led growth, in total, there will be additional 2.6 million people lifting out of poverty in the agriculture-led growth compared to non-agriculture-led growth, despite the fact that overall GDP grows at the similar rate under the two scenarios.

[27] The poverty-growth elasticity used in this study measures the responsiveness of the poverty rate to changes in the per capita GDP growth rate. The formula for this elasticity is:

$$\frac{\Delta P_0 / P_0}{\Delta GDPpc / GDPpc} = \frac{\Delta P_0}{\Delta GDPpc} \cdot \frac{GDPpc}{P_0}$$

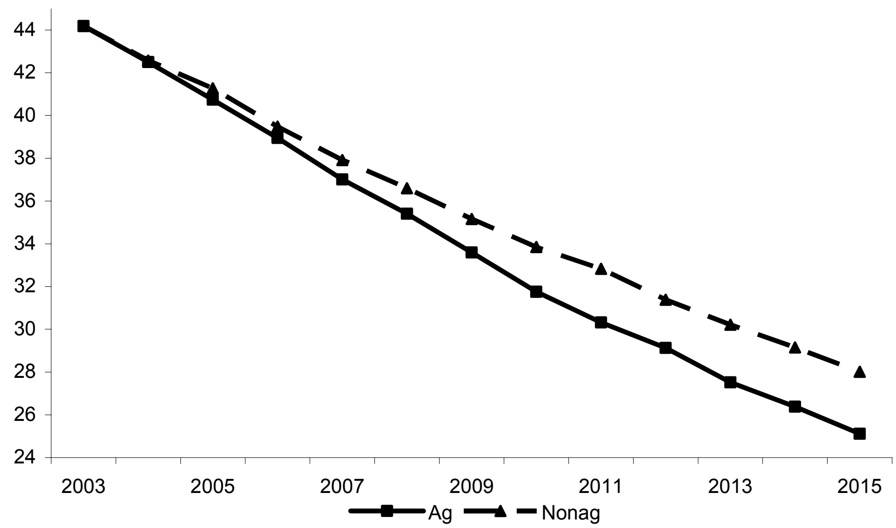
where ΔP_0 and $\Delta GDPpc$ are average annual changes (from the base-year) in the poverty headcount *rate* and *level* of per capita GDP; and P_0 and $GDPpc$ are the base-year poverty headcount rate and per capita GDP. The poverty-growth elasticity measures the percentage change in the poverty headcount rate caused by a one-percent increase in per capita GDP. This is *not* equivalent to a percentage point change in the poverty headcount rate.

Table 5: Agricultural growth is more pro-poor

	Baseline scenario	Agriculture-led growth scenario	Non-agriculture-led growth scenario
Annual per capita GDP growth rate (%)	1.9	2.9	2.9
Annual non-agricultural production growth rate (%)	5.9	6.1	7.7
Annual agricultural production growth rate (%)	3.1	4.7	3.2
Staples (staple crops and livestock)	3.1	4.3	3.2
Export crops	3.1	7.7	3.0
Poverty headcount by 2015 (%)	32.1	25.1	28.0
Difference in poor population in 2015 (1,000)		-6,332	-3,682
Poverty-growth elasticity	-	-1.9	-1.2

Source: Authors calculation from the EMM model results

Figure 3: National Poverty Rate (%) in Agriculture-led and Non-agricultural-led Growth Scenarios Both with 5.5% GDP annual growth



Source: Authors calculation from the EMM model results

6. Conclusions

The paper applied two complementary approaches to assess agricultural growth linkages in Ethiopia. Both approaches reveal the same pattern of linkages, albeit with differences in the magnitudes involved.

Estimates based on a fixed-price semi-input-output (SIO) model indicate that large growth linkages are generated by most of the sectors examined. Nevertheless, those induced by agricultural activities are larger. This difference arises primarily because of much higher value-added created by the direct increase in agricultural outputs. As a fraction of the gross value of output, value-added can be as high 91 percent in agriculture, the sectoral average being 78 percent. The flexible-price economywide multimarket (EMM) model, which also accounts for spatial differences, produces comparable, albeit smaller, estimates for staples and agricultural exportables.

Model results reveal that the impact of growth on poverty is larger when the additional growth is driven by agriculture rather than non-agriculture. Given its larger impact on poverty, agricultural-led growth in Ethiopia lifts more rural people out of poverty compared to non-agricultural-led growth. Non-agriculture-led growth reduces urban poverty more than agriculture-led growth. In total, however, there will be a larger number of people coming out of poverty in the agriculture-led growth compared to non-agriculture-led growth, despite the fact that overall GDP grows at the same rate in both scenarios.

Estimates also imply that growth in staple production will generate more than proportionate increase in total GDP. Moreover, such growth linkages become stronger over time. On the other hand, the linkages from agricultural exports to total GDP is strong only in the initial five years, the linkages become weaker overtime, and the growth multipliers fall below one by 2015.

In light of the usual focus on exports, it is useful to briefly comment on why growth in staple crops has such a significant effect. Cereals and other staple crops are the most important income source for the majority of small farmers. Domestic supply of staple crops is the most important source of food energy for both rural and urban poor consumers. Both of these features are likely to continue to apply for the next 10 years or so (the horizon being examined, that is) Thus, raising productivity in staple crops will increase the food supply, lower food prices, and help reduce the poverty rate in both rural and urban areas. Clearly, better incentives and improved production conditions will give farmers more opportunities to diversify. As a consequence, many presently subsistence crops grown extensively by poor farmers can become marketable commodities and this shift would further increase poor farmers' cash income.

Furthermore, once growth in the agricultural sector is combined with improved marketing margins through cross-sector linkage effects, both GDP and agricultural GDP grow more rapidly. Reducing marketing costs primarily benefits smallholders via the increased net prices they receive for their goods, thereby raising their income from the same level of output. Improving market conditions also creates a more efficient trading sector as well as other service sectors, which itself can generate greater non-agricultural income without increasing costs. Due to such cross-sector linkages and positive price effects, the poverty rate can decline significantly, the decline being more pronounced in rural areas.

While market improvement supports agricultural growth and generates additional non-agricultural growth (though mainly in trade-related services), broad non-agricultural growth, including manufacturing and other services, is also critical. Non-agricultural growth not only creates non-farm opportunities and rural income but also increases urban income; further, rural non-farm income creates market demand for agriculture. Cross-sector linkage effects induce additional non-agricultural growth over and above that generated by the agricultural growth and market improvements discussed above. As a consequence, GDP grows faster and poverty declines more rapidly.

As noted at the beginning of the paper, Ethiopia has embarked upon an agriculture-based growth strategy to meet the challenges of accelerating overall growth and poverty reduction. Three sets of key questions were subsequently highlighted as relevant to the implementation of such a strategy. These were: which sectors have large prospective linkages; what are the growth and poverty-reduction potential of these sectors and constraints thereof; and what policy interventions are capable of unlocking the growth potential. Relative to these, the key findings of this analysis are that:

Agricultural growth induces higher overall growth than non-agricultural growth. It also leads to faster poverty reduction since it generates proportionately more income for farm households who represent the bulk of the poor. From within agriculture, staple crops have stronger growth linkages.

Consumption linkages are much stronger than production linkages. In most cases, the impact of increased consumption demand due to growth (agricultural and non-agricultural) is much larger than that of the corresponding expansion in input demand.

Non-agricultural growth cannot be neglected, however. Such growth can, in its own right, have large growth effects in some cases. More importantly, non-agricultural sectors have to grow in order to match growing supply of agricultural products and increasing demand for non-agricultural products. Otherwise, falling prices of agricultural products may dampen the realized gains in growth and poverty reduction. Given the rather small industrial sector, import-substitution investments in the relevant sectors appear necessary to achieve success.

The key message is, therefore, that exploiting the potential growth linkages towards poverty reduction and structural transformation require a diversified (or 'balanced') growth strategy that encompasses agricultural staples and exportables as well as non-agricultural sectors. On the one hand, the explorations of this paper imply that the emphasis of ADLI and PASDEP on agricultural growth is, in principle, warranted. On the other hand, the results also clearly show that exclusive focus on agriculture (or insufficient attention to non-agriculture) is counter-productive. It would at best lead to unsatisfactory outcomes in growth and poverty reduction. The greater comprehensiveness of PASDEP suggests that policy-makers may have learnt that lesson.

Finally, the models employed by the paper are specifically designed to measure the size and composition of growth linkages triggered by a growing sector. As such they are not directly useful as a means of exploring questions like why and how growth, be it in agriculture or any other sector, occurs in the first place. The returns to an in-depth diagnostics are clearly substantial.

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Appendix A

Table A1: The Structure (or Accounts) of the 2001/02 Ethiopian Social Accounting Matrix (SAM)

Activities (Sectors)	**Commodities**	**Factors**
Subsistence Crop Farming - Highland	Barley	Family labour
Subsistence Crop Farming - Lowland	Maize	Wage labour
Subsistence Livestock Farming - Highland	Sorghum and Millet	Capital - infrastructural
Subsistence Livestock Farming - Lowland	Teff	Capital - other
Commercial farming - public	Wheat	Land
Commercial farming - private	Other Cereals	
Forestry and Fishing	Pulses and oilseeds	**Households**
Large/medium-scale Manufacturing	Root crops	Subsistence Farm households
Food, beverages, and tobacco	Coffee, tea, and chat	Wage earners
Textile and leather	Fruits	Entrepreneurs (self-employed and/or capitalists)
Other	Vegetables	
Small-scale, Cottage, and Handicraft Manufacturing/processing	Other crops	**Firms/Enterprises**
Food, beverages, and tobacco	Livestock	Subsistence household farms
Textile and leather	Livestock products	Private Enterprises
Other	Forestry and Fishing	Public enterprises
Mining and Construction	Manufactured food, beverages, and	
Utilities	Textile and leather	**Saving/Investment (or Capital)**
Trade, Transport, and Communications	Other manufactured products	Government Investment on Infrastructure
Tourism, Hotels, and Restaurants	Mining and Construction	Government Investment on Education and Health
Health and Education	Utilities	Government Investment - Other
Public Administration	Trade, transport, and communications	Capital - Other
Other Services	Tourism, hotels, and restaurants	
	Health and education	**Others**
	Public administration	Government recurrent
	Other services	Transactions Costs
		Rest of the World

Table A2: Income Distribution[28]

Household Type	Income (in million Birr)	Share (%)
Farm Households	27,448	50.4
Wage earners	16,334	30.0
Entrepreneurs	10,717	19.7
Total	**54,499**	**100.0**

Source: Ethiopian SAM 2001/02.

Table A3: Composition of Domestic Demand

	Share in Domestic Demand (%)					
Commodity/Sector	**Household Consumption**	**Intermediate Consumption**	**Government consumption**	**Investment**	**Domestic Production**	**Imports**
Cereals	84.9	15.1	0.0	0.0	86.4	13.6
Pulses and oilseeds	81.5	18.5	0.0	0.0	98.9	1.1
Coffee, tea, and chat	63.0	33.6	0.0	3.4	98.6	1.4
Fruits and Vegetables	92.5	7.5	0.0	0.0	99.3	0.7
Other Crops	98.6	1.4	0.0	0.0	99.4	0.6
Livestock and Livestock Products	68.1	31.9	0.0	0.0	99.7	0.3
Forestry and Fishing	30.9	50.6	0.0	18.5	99.9	0.1
Agriculture	***69.6***	***27.0***	***0.0***	***3.4***	***96.0***	***4.0***
Manufactured food, beverages, and tobacco	76.1	18.6	0.0	5.3	96.8	3.2
Textile and leather	83.5	12.6	0.0	3.9	71.9	28.1
Other manufactured products	12.8	56.7	0.0	30.6	36.4	63.6
Other Industrial Products	8.8	37.4	0.0	53.8	100.0	0.0
Industry	***28.2***	***41.3***	***0.0***	***30.5***	***66.6***	***33.4***
Trade, transport, and communications	26.3	73.7	0.0	0.0	70.2	29.8
Services - Other	36.2	21.7	38.9	3.2	91.9	8.1
Services	***34.9***	***28.6***	***33.8***	***2.8***	***89.0***	***11.0***
Total	**43.7**	**32.8**	**10.1**	**13.3**	**82.9**	**17.1**

Source: Ethiopian SAM 2001/02.

[28] The total income of rural households does not exactly coincide with that of farm households. Many rural households derive their incomes mainly from non-farm activities. Also, the income of farm households itself is underestimated since a fraction of such households are likely to earn some income from non-agricultural activities. Indeed, non-agricultural activities account for about 12 percent of rural employment (CSA (November 1999) and CSA (May 2006)). On the other hand, it is fairly accurate to identify wage-earners and entrepreneurs as urban dwellers and estimate urban income as the sum of their incomes.

Table A4: Consumer Spending Patterns in Ethiopia

Item	Average Budget Share (%)			Marginal Budget Shares (%)		
	Farm	*Wage*	*Entrepreneurs*	*Farm*	*Wage*	*Entrepreneurs*
Cereals						
Barley	2.8	0.6	0.2	0.9	0.1	0.1
Maize	8.3	3.2	0.5	2.4	-0.9	-0.5
Sorghum and Millet	5.1	1.5	0.2	2.8	-0.3	-0.2
Teff	6.9	15.5	7.6	7.0	5.0	2.9
Wheat	5.6	4.0	1.3	5.8	0.5	0.3
Other Cereals	0.0	0.2	0.2	0.3	0.4	0.2
Sub-total	***28.7***	***25.0***	***10.0***	***19.2***	***4.8***	***2.8***
Other Food						
Pulses and oilseeds	6.5	5.0	2.1	3.9	1.0	0.6
Root crops	7.2	1.9	0.6	1.3	0.2	0.1
Coffee, tea, and chat	4.2	3.2	1.5	5.1	1.1	0.6
Fruits	0.3	0.2	0.2	0.8	0.2	0.2
Vegetables	2.2	3.4	2.1	1.2	2.2	1.3
Other crops	3.6	3.1	1.6	2.0	1.3	0.8
Livestock	0.1	0.0	0.0	0.4	0.0	0.0
Livestock products	6.0	5.3	5.6	8.5	8.3	5.1
Forestry and Fishing	7.0	3.6	1.6	3.4	0.9	0.5
Manufactured food, beverages, and	3.7	11.2	7.3	-5.0	8.3	5.1
Sub-total	***40.8***	***36.9***	***22.6***	***21.6***	***23.5***	***14.3***
Non-food - Industry						
Textile and leather	8.6	9.3	10.9	12.9	16.7	10.3
Other manufactured products	4.8	7.1	10.0	7.3	19.1	13.3
Mining and Construction	0.1	0.1	0.2	0.9	1.6	1.1
Utilities	1.6	3.2	2.5	0.9	2.9	1.8
Sub-total	***15.1***	***19.7***	***23.6***	***22.0***	***40.3***	***26.5***
Non-food - Services						
Trade, transport, and communications	0.6	2.1	4.0	1.2	5.0	4.9
Tourism, hotels, and restaurants	0.7	0.9	1.6	1.1	1.8	1.1
Health and education	0.2	0.4	0.5	0.2	0.8	0.5
Public administration	0.3	0.4	0.5	0.3	0.7	0.5
Other services	13.6	14.7	37.3	34.6	23.2	49.3
Sub-total	***15.4***	***18.5***	***43.9***	***37.4***	***31.5***	***56.3***
Total	100.0	100.0	100.0	100	100	100

Source: Wamisho and Yu (2006).

Table A5 - Agricultural Growth Multipliers in Ethiopia - Scenario I

	Cereals (Maize)		Cereals (Teff)		Coffee		Livestock	Livestock Products	Manufacturing (Textiles)	Manufacturing (Other Manufactures)
	Traditional	***Modern***	***Traditional***	***Modern***	***Traditional***	***Modern***	***Traditional***	***Traditional***		
Shock										
Gross Output	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Value-added	0.61	0.57	0.70	0.67	0.16	0.15	0.58	0.52	0.12	0.05
Resulting change in GDP	1.97	2.08	2.18	2.31	3.45	3.48	1.97	1.96	1.41	1.16
Resulting change in household income										
Farm households	0.74	0.37	0.84	0.42	0.49	0.38	0.86	0.81	0.18	0.11
Wage earners	0.29	0.55	0.32	0.62	0.72	0.80	0.26	0.27	0.28	0.21
Entrepreneurs	0.29	0.33	0.33	0.37	0.67	0.68	0.28	0.29	0.21	0.17
Total	1.32	1.25	1.48	1.40	1.88	1.86	1.40	1.37	0.67	0.49
Value added multiplier	3.24	3.63	3.13	3.47	21.24	22.65	3.38	3.77	12.02	21.61

Source: Semi-input output model simulations based on the 2001/02 Ethiopian SAM.

Table A6 - Share of Consumption Linkages in Agricultural Growth Linkages - Scenario I

	Cereals (Maize)	Cereals (Teff)	Coffee	Livestock	Livestock Products	Manufacturing (Textiles)	Manufacturing (Other Manufactures)
	Traditional	***Traditional***	***Traditional***	***Traditional***	***Traditional***		
Shock							
Gross Output	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Value-added	0.61	0.70	0.16	0.58	0.52	0.12	0.05
Resulting change in GDP							
Consumption and Production Linkages	1.40	1.64	2.38	1.52	1.50	0.80	0.42
Production Linkages only (MPC=0)	0.97	1.14	1.71	1.03	1.02	0.63	0.36
Decomposition of the income gain							
Total Income Gain	0.79	0.94	2.21	0.94	0.98	0.69	0.37
Production Linkages	0.36	0.44	1.55	0.45	0.50	0.51	0.31
Consumption Linkages	0.43	0.51	0.66	0.48	0.47	0.18	0.06
% Total Income Gain due to Consumption Linkages	54.4	53.7	30.0	51.6	48.4	25.8	16.7

Source: Semi-input output model simulations based on the 2001/02 Ethiopian SAM.
Note: MPC stands for 'marginal propensity to consume'.

Table A6: Agricultural commodities included in the economy-wide multi-market model

Maize, Teff, Wheat, Sorghum, Barley, Millet, Oats, Rice,
Potatoes, Sweet potatoes, Enset, Other root crops,
Beans, Peas, Other pulses,
Groundnuts, Rapeseed, Sesame, Other oil crops,
Domestic vegetables, Bananas, Other domestic fruits,
Exportable vegetables, Other horticultural crops, Chat, Cotton,
Coffee,
Sugar, Beverages and spices
Bovine meat, Goat meat and mutton, Other meat,
Milk and dairy products,
Poultry and eggs, Fish

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IFPRI HEADQUARTERS

2033 K Street, NW
Washington, DC 20006-1002 USA
Tel.: +1-202-862-5600
Fax: +1-202-467-4439
Email: ifpri@cgiar.org

IFPRI ADDIS ABABA

P. O. Box 5689
Addis Ababa, Ethiopia
Tel.: +251 11 6463215
Fax: +251 11 6462927
Email: ifpri-addisababa@cgiar.org

IFPRI NEW DELHI

CG Block, NASC Complex, PUSA
New Delhi 110-012 India
Tel.: 91 11 2584-6565
Fax: 91 11 2584-8008 / 2584-6572
Email: ifpri-newdelhi@cgiar.org