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TOWARD AN UNDERSTANDING OF ECONOMIC GROWTH IN AFRICA: A RE-INTERPRETATION OF THE LEWIS MODEL

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ABSTRACT

Africa's recent economic growth is at a historical high. The patterns associated with this growth appear to be quite different from the Asian experiences where rapid growth was fueled by labor intensive, export-oriented manufacturing. Because this pattern differs with our typical view of structural transformation, a heated debate has begun over the sustainability of Africa's growth. One thing is clear: the recent growth is not well understood. Against this background, we adapt Lewis's (1954) dual-economy model to the economies of Africa to better understand the role that the "in-between" sector as defined by Lewis (1979) has played in Africa's recent growth. Our framework incorporates the coexistence of a closed and an open modern economy and takes into account the diversity and heterogeneity of the activities that characterize modern African economies. We apply this framework to the economy of Rwanda to assess Rwanda's future growth prospects based on different levels of foreign capital inflows. We find that higher foreign inflows lead to significantly more growth in the closed modern economy and stagnant growth in the open modern economy, a phenomenon consistent with recently observed patterns of growth across several African countries.

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1. INTRODUCTION

> *An economy does not divide into a capitalist sector hiring workers for factories and other large units on the one hand, and a small farming sector on the other hand. In between are units of production of all sizes, and in particular a great number of one-to-five-man undertakings in manufacturing, transport and a wide range of services—often nowadays called the informal sector. Some of this activity belongs in the modern sector as we have defined it; i.e., it will expand with economic development; the rest— – e.g., some of the handicrafts and some of the services—belong to the traditional sector in that they will contract.*
>
> *The expansion of small scale activity in the modern sector is an important part of the development process. This is not because it is a temporary resting-place for migrants from the countryside seeking jobs in large scale enterprise. In LDCs, no less than in MDCs (as we shall see in our next section) jobs in large scale urban enterprises are not normally awarded to people who have no connections. It is rather because this sector of the economy is useful in its own right, meeting genuine market needs, and providing a lot of employment in the process.*
>
> Arthur Lewis, "The Dual Economy Revisited

Africa's recent economic growth has sparked a heated debate over its sources and sustainability. Some argue that growth across the continent is fundamentally a result of a mining boom and rising commodity prices (Lipton 2012). The underlying tone of this message is that when commodity prices collapse, so too will Africa's growth rates. A more fundamental concern is that Africa's recent growth has not been accompanied by adequate structural change (see, among others, the United Nations Economic Commission on Africa [2014] and the African Center for Economic Transformation [2014]). What has been seen as poor prospects for industrialization has led some to argue that we need to manage our expectations about Africa's future growth prospects (Rodrik 2014a).

In this paper, we argue that Africa's recent growth is not well understood. We do know that the growth has not been driven by labor-intensive large-scale manufacturing in the way it was in many developing Asian countries (McMillan and Harttgen 2014). But we are equally ignorant about the roles that domestic markets and small and medium-size enterprises have played in Africa's recent growth. In China and Vietnam and in many other Asian countries, large declines in the employment share in agriculture were matched by significant increases in the employment share in labor-intensive and export-oriented manufacturing. Instead, the recent and significant decline in the employment share in agriculture in most African countries has been accompanied by a proliferation of small and medium-size enterprises in manufacturing, transportation, construction, and a wide range of services.

Because such enterprises often operate in the informal sector, they are typically viewed as backward and unproductive and as an employer of last resort. In fact, there is a tendency by researchers to lump them all together into what Lewis (1954) described as the traditional sector.[1] But as Lewis (1979) clearly points out, such enterprises exhibit a wide range of heterogeneity with many looking more like modern than traditional-sector firms. Further, he says, these "in-between" enterprises play a very important role in the development process meeting genuine market needs and providing sorely needed employment in the process.

This in-between sector has been growing more rapidly in most African countries than the large-scale modern manufacturing and services sectors. Thus, Africa's growth cannot be explained without considering the contribution of such activities. This represents a challenge because counting activity in this sector is difficult; many of the businesses are unregistered and their owners often do not keep accounts. The practical ramifications of these issues are well illustrated by the recent national account rebasing in Nigeria and Ghana. In Nigeria, officials discovered an additional 89 percent of value-added that was mostly accounted for by small and informal manufacturing and services. A similar exercise was done in Ghana in 2007 and also revealed an additional 60 percent of gross domestic product (GDP), again, mainly derived from small businesses.

[1] In addition there is a tendency to lump informal-sector workers in Africa together with informal-sector workers in Latin America, but arguably the conditions that lead to informality are very different across these two continents.

These businesses often produce the same goods and services as those produced in the formal modern sector albeit of a different quality. Next to the Four Seasons hotel in Tanzania's Serengeti, there are hotels for those on a more modest budget with chairs, beds, food, and drinks all made by local businesses. Meanwhile, practically everything at the Four Seasons is imported (including the customers!) except of course the labor. In a national accounting sense, the productivity of the housekeeper at the Four Seasons will be multiples of the productivity of the housekeeper in the local hotel because the Four Seasons is highly capital intensive and not because the workers are of a different quality nor because they are doing different jobs. There are thousands of local hotels that provide decent jobs whereas there is (so far) only one Four Seasons with a handful of jobs. Thus, as large amounts of labor exit from agriculture, as Filmer and Fox (2014) predict, many of those laborers will end up owning, operating or working for small businesses. The implication is that this sector has been and will continue to be an important driver of structural change and growth in Africa.

One indication that African policymakers understand very well the importance of the in-between sector is that—for the first time—large scale nationally representative surveys of small and medium-scale enterprises are being conducted. As of the writing of this paper, we know that surveys have been carried out in Nigeria, Rwanda, Tanzania, and Zambia, and that several more are planned. Thus, for the first time in Africa's modern history, we have some data to investigate the nature of these enterprises.[2] The results are interesting and support Lewis's emphasis on the importance of such enterprises in the development process. For example, the government of Tanzania just finished its *first* nationally representative survey of micro, small and medium-size firms (Tanzania, Ministry of Industry and Trade 2012). Here are some of the more interesting results:

- There are more than 3 million such enterprises employing around 5.2 million people.
- More than half of such enterprises are in rural areas.
- Sixty percent of these enterprises report that their businesses are growing.
- Fifty-four percent of enterprise owners report that they would not give up their job for a full-time salaried position.
- Overall, 14 percent of the enterprises are in the manufacturing sector, and in rural areas, 18 percent of the enterprises are in the manufacturing sector (while in the national account, manufacturing accounts for less than 4 percent).
- Virtually none of the small firms export—their markets are purely domestic.

Thus, whereas some of the enterprises belong in the traditional sector as conceptualized by Lewis (1954), many do not.

So, where does this leave us? In our view, the coexistence of "in-between" and large-scale activities within a given sector for producing similar products or services is not a sign of the failure of the development process. Instead, it is an indication of a kind of dualism within the modern sector. When seen this way, it opens our minds to thinking about the development process in a different way. For example, such an in-between economy can now take center stage in a growth strategy. Rather than viewing such enterprises as a sign of development failure, governments can include them in the policy dialogue and devise strategies that facilitate their growth. Of course, this is already happening. As Temple (2005) points out, the central problem policymakers face in developing countries is not simply how to raise growth rates, but rather, which policies will promote *labor-intensive growth* and raise the incomes of the poorest members of society. By placing these strategies within the context of the Lewis (1954) model it may help us think about them in a more organized way.

The beauty of Lewis's 1954 article is that he described the process of development as an "open system" in the sense that he did not write down a formal neoclassical model closing off options for growth. Thus, as researchers we can take from him the essential features of his "model" like duality in the labor market and adapt them to the situation at hand. To us, this means downplaying the role of the

[2] Previous surveys, including those conducted by the World Bank, have tended to be tiny (for example, as small as 128 firms) and not nationally representative.

"traditional" sector and emphasizing the role of the "in-between" sector that we described above—and that Lewis (1979) himself wrote about. For the purposes of this paper, we look into the modern economy as a process of development and divide Lewis's modern sector into two parts: the open economy that competes in international markets and the closed economy that does not compete in international markets. Although in reality, most goods and services will fall along a continuum according to their connections with the global economy, for simplicity we divide the modern economy into these two sectors and also do not consider the traditional sector that still exists in many African economies. Or in the words of Loasby (2003) we close our minds to the many possibilities of Lewis's open system to concentrate on a few that we think are important. We argue that both the closed and the open parts of the modern economy are sources of growth including productivity growth. However, the two economies face different opportunities and constraints in growth, and the speed of evolution or expansion of the two economies determines the change in economic structure.

Furthermore, although in our framework, economywide growth can be driven by growth in either the closed or the open part of the modern economy, in this paper, we do not focus too much on growth in the open part as that topic has been widely covered in the literature. Instead, we emphasize the role of the closed part of the economy and its linkages with the open part through which productivity growth in the closed part will be facilitated. For example, hybrid seeds, which are highly tradable, can lead to significant yield increases in grain crops grown by market oriented farmers in the closed part of the economy for the domestic market, and the introduction of modern telecommunications technology can boost output and productivity among many activities in the closed part of the economy.

Using this framework we then ask the following question: how do Africa's future growth prospects depend on the level of foreign inflows? We focus on foreign inflows because much of the argument around sustainability revolves around the concern that if foreign inflows cease, so too will growth. We perform this analysis using data from Rwanda because Rwanda is characteristic of many of the high-growth countries in Africa whose growth has not been driven by natural resources. However, the results are generalizable to a country where foreign inflows come primarily from natural resources. Using a general equilibrium model we simulate two growth scenarios for the 2012–2025 period: one based on continued high growth in foreign capital inflows, and the second based on a substantial reduction in foreign capital inflows.

We find that whereas the difference in the impact of different levels of foreign inflows on economywide growth can be modest, the impact on the composition of economic growth can be significantly different. Foreign inflows finance infrastructure investment, but they can also cause real exchange rate appreciation. Thus, high foreign inflows stimulate growth primarily in the closed part of the economy. By contrast, high foreign inflows can have a negative impact on growth in the open part of the modern economy by making exportables less competitive. Finally, when growth is less dependent on foreign inflows, the contribution of structural change to overall growth is larger because productivity becomes higher in the open part of the modern economy.

We are certainly not the first to come up with our own interpretation of the Lewis (1954) model. And to be clear, in this paper, we do not seek to formalize the Lewis model. Many researchers have done that in a variety of ways; for a recent treatment of alternative micro-foundations of the Lewis model, readers are referred to Wang and Piesse (2013). Instead, we combine insights from Lewis (1954) with Lewis's own reflections on the original model 25 years later (Lewis 1979) to better conceptualize growth as a development process in modern Africa.

The remainder of this paper is organized as follows. In Section 2 we present some stylized facts about Africa's recent growth. This set of stylized facts leads us to revisit the Lewis model in Section 3 of the paper, adapting it to the conditions of modern Africa. Section 4 applies this framework to Rwanda to simulate and analyze alternative growth scenarios. Section 5 concludes.

2. CHARACTERISTICS OF DEVELOPING AFRICA'S GROWTH IN THE 21ST CENTURY

In this section of the paper, we present a number of stylized facts about growth in Africa south of the Sahara (SSA) in the 21st century. Mauritius and South Africa are excluded from the analysis because both countries are far more industrialized than the rest of SSA. Mauritius has reached a point in its development whereby the sectors that are expanding are the highly productive service sectors; and South Africa already has a relatively large manufacturing sector but faces unique challenges due to the legacy of apartheid. Thus, our sample includes 39 developing countries in SSA; five small countries with a population of less than one million are excluded as are Somalia and South Sudan as data are not available for those two countries.

Fact 1: Growth Is Relatively Balanced

Table 2.1 presents average annual growth rates in GDP per capita as well as growth rates in sectoral GDP per capita for agriculture, manufacturing, and services. We report simple average growth rates; the 38 countries are divided into four groups according to whether GDP and agricultural GDP per capita growth rates are above or below the continental average. High-High indicates rapid growth in both GDP and agricultural GDP per capita. High-Low indicates rapid growth in GDP per capita with growth in agricultural GDP per capita below average. Low-High indicates lower-than-average growth in GDP per capita and high growth in agricultural GDP per capita. Finally, Low-Low indicates lower-than-average growth in both GDP and agricultural GDP per capita.

Table 2.1 African countries' economic growth in the 21st century

	Per capita annual growth rate, 2000–2012				Number of	# of countries with SerGDP	# of countries with MfgGDP
Variable	GDP	AgrGDP	MfgGDP	SerGDP	countries	gr > GDP gr	gr > GDP gr
Total/Mean	2.6	1.0	2.2	3.5	39	28	11
High-High	4.8	3.9	4.0	6.1	11	10	3
High-Low	3.5	-0.6	2.4	3.8	6	3	2
Low-High	1.3	1.8	1.1	2.0	5	4	2
Low-Low	0.3	-0.9	0.4	1.0	17	11	4

Source: GDP data from UNSD (2014) and population data from World Bank (2014).

Notes: GDP = gross domestic product; Agr = agriculture; Mfg = manufacturing; Ser = services; gr = growth. The calculation considers developing countries in Africa south of the Sahara only (excluding South Africa and Mauritius). Five African countries with a population of less than one million, and Somali and South Sudan without data, are excluded. The first letter in each row of the first column is according to GDP per capita greater than (high) or below/equal to (low) the continental mean; and the second letter is according to AgrGDP per capita greater than (high) or below/equal to (low) the continental mean. The mean is a simple average of growth rate across African countries and considering the countries with positive per capita GDP growth only (while the countries still can have negative growth at sector level). The numbers of the countries reported in the table include five countries with a negative per capita GDP growth rate, all in the Low-Low group.

Since we are interested in understanding the rapid growth in the majority of African countries during this period, we exclude countries with an overall negative annual growth rate in GDP per capita in calculating the continentwide average growth rate. However, the countries with positive overall growth in GDP per capita can still have negative growth in a specific sector. Based on this principle, the average annual growth rate for the continent as a whole is 2.6 percent for GDP per capita, 1.0 percent for agricultural GDP per capita, 2.2 percent for manufacturing, and 3.5 percent for services, both in per capita measures.

A total of 17 African countries have per capita GDP growth rates higher than the continental average—we call those countries *fast-growth* countries. Among those 17, 11 are in the High-High group and 6 are in the High-Low group (Table 2.1, column 5). The High-High countries as a group have agricultural GDP per capita annual growth rates 3.9 times the continental average of 1.0 percent, and in addition, their GDP per capita annual growth rate is 85 percent higher than the continental average of 2.6

percent. In fact, in that group, three countries, Angola, Ethiopia, and Nigeria, have GDP per capita growth rates higher than 6 percent. We call those three countries the *best-growth* performers in Table 2.2. Seven countries, Rwanda, Mozambique, Sierra Leone, Chad, Tanzania, Ghana, and Uganda, have growth rates one percentage point higher than the regional average (that is, higher than 3.6 percent)—we call those countries *good-growth* performers (Table 2.2, column 1). Among those seven countries, all but Chad and Uganda are in the High-High group.

Table 2.2 Growth rate in per capita GDP and share of nonmanufacturing industry and services in GDP

	Growth rate in per capita						Share of GDP in current prices			
							Mining		Services	
Country	GDP	AgrGDP	MfgGDP	MiningGDP	IndGDP	SersGDP	2000	2012	2000	2012
Best-growth performers										
Angola	8.0	8.4	11.7	5.5	6.5	8.6	67.0	49.2	21.4	27.5
Ethiopia	6.4	4.5	5.7	7.6	7.6	7.1	2.6	2.5	39.8	10.0
Nigeria	6.2	6.0	6.0	-0.3	0.5	9.4	47.9	37.4	21.8	26.3
Good-growth performers										
Rwanda	5.4	2.2	4.6	-1.8	6.8	7.9	1.0	1.2	45.6	48.0
Mozambique	4.8	4.7	3.9	4.1	4.8	5.2	3.3	6.0	52.3	47.6
Sierra Leone	4.8	5.5	2.2	1.2	7.1	2.4	3.8	23.3	42.2	36.0
Chad	4.4	0.4	1.5	-4.4	11.3	4.0	0.6	44.1	46.4	29.0
Tanzania	4.0	1.3	5.6	5.3	6.0	4.8	4.2	6.1	47.9	47.6
Ghana	3.8	1.8	1.6	8.9	6.1	4.3	4.6	10.0	48.1	50.0
Uganda	3.6	-1.3	2.9	1.4	4.8	4.5	3.8	4.2	49.1	49.7
Other fast-growth countries										
Namibia	3.3	-2.2	3.7	1.5	3.3	3.9	12.7	14.9	60.9	61.2
Lesotho	3.3	-0.6	3.7	6.8	4.5	3.2	5.0	12.3	57.7	58.3
Burundi	3.2	1.3	-0.3	10.1	1.6	6.1	1.1	2.0	40.7	39.5
Botswana	3.1	2.6	4.3	-4.6	-1.2	5.7	38.9	21.0	46.4	62.2
Zambia	3.0	0.3	1.6	5.0	6.0	2.6	7.8	5.2	55.2	42.6
Burkina Faso	2.8	5.2	-0.9	9.7	3.2	4.7	1.8	8.7	45.6	43.6
Congo, Dem. Rep.	2.7	-0.1	1.5	6.3	5.2	4.0	11.1	13.3	30.2	32.6
Slow-growth countries										
Benin	0.6	0.3	-1.0	-0.9	0.2	1.2	1.1	1.4	48.2	50.2
Cameroon	0.7	1.4	-0.8	-7.0	-2.2	3.2	12.4	8.8	42.3	47.6
Central African Republic	-0.1	-0.1	1.2	-1.6	0.4	-0.7	5.0	2.8	33.3	32.0
Congo, Rep.	2.0	1.9	6.1	0.1	0.7	3.1	67.8	70.5	20.7	0.0
Cote d'Ivoire	-0.5	-0.7	-3.6	2.5	-3.6	-2.2	1.9	5.2	47.8	0.0
Eritrea	-2.8	-0.2	-8.3	26.7	-1.8	-3.9	1.3	1.7	61.9	0.0
Gabon	-0.1	0.7	6.9	-2.6	-1.5	1.2	54.0	62.4	36.0	26.9
Gambia, The	0.2	-1.4	-0.5	8.5	0.2	-0.4	1.2	4.4	61.7	61.8
Guinea	0.1	-1.8	0.8	0.4	0.5	0.9	18.5	19.4	44.6	41.0
Kenya	1.7	-0.7	1.4	2.5	1.9	1.9	2.7	2.3	49.9	53.2
Liberia	0.3	-2.7	8.2	43.8	12.5	1.3	0.2	3.0	28.8	17.9
Madagascar	0.1	-0.7	-0.5	-4.8	1.2	0.4	1.9	1.9	55.2	51.2
Malawi	1.5	-4.0	10.8	23.2	8.7	0.0	2.3	2.4	45.0	51.9
Mali	1.6	2.6	-2.7	0.9	-0.7	1.8	8.0	11.0	42.9	35.8
Mauritania	2.3	-0.7	-5.4	4.7	2.3	4.6	12.9	23.4	36.7	38.9
Senegal	1.2	-0.3	-0.3	0.7	0.7	2.0	3.9	4.8	57.6	58.7
Sudan	1.4	1.3	3.1	-5.1	2.3	1.8	8.1	2.5	45.6	41.6
Swaziland	1.0	-0.3	-0.7	-15.8	-0.7	2.9	1.4	1.4	44.9	47.2
Togo	0.1	-1.1	0.6	-4.6	0.4	0.4	7.4	7.8	42.4	35.7
Zimbabwe	-0.7	-4.8	-0.9	1.3	0.6	-1.2	3.4	15.8	58.3	48.1

Source: UNSD (2014).

Notes: Agr = agriculture; Mfg = manufacturing; Ind = industry; Sers = services. The 17 fast-growth African countries are ranked according to growth rate in gross domestic product (GDP) per capita. Guinea-Bissau and Niger are in the slow-growth group and are excluded from this table due to sector data unavailable. The mining GDP includes the utility subsector as the data are reported in that way.

Columns 6 and 7 of Table 2.1 report the number of countries in which the services and manufacturing growth rates are higher than GDP growth by group. Indeed, in most countries (30 of 38) services GDP grows faster than total GDP; this is true for 10 of the 11 countries in the High-High group (except for Sierra Leone) and it is also true for three of the other six top growth performers, except for Chad, Lesotho, and Zambia (Table 2.2, column 6). In terms of manufacturing GDP, as shown in column 7 of Table 2.1, 6 of the 17 fast-growth countries have manufacturing GDP growth rates higher than their average GDP growth rate, and there are another four countries with manufacturing growth rates close to the rate of GDP growth (Table 2.2, column 3). For the three best-growth performers, manufacturing GDP per capita also grew rapidly, either higher than or close to their average GDP growth rate. For the other seven good-growth performers, three have manufacturing GDP per capita growth rates in the same range as average GDP growth (Table 2.2, column 3). For developing African countries as a whole, manufacturing growth was just slightly lower than total GDP growth (Table 2.1, row 1).

Thus, it seems to us that, for many fast-growing economies in Africa, the sectoral growth rates across agriculture, manufacturing, and services are quite balanced. The fact that growth in agricultural GDP is generally lower than the growth rate in the nonagricultural sectors is to be expected. Agriculture produces food staples for the domestic market and such products have low income elasticity of demand. While it is true that nontraditional agricultural production can grow rapidly, this typically constitutes a very small share of agricultural production.

Fact 2: Growth Is Not Led by Natural Resources Alone

From Table 2.2 we learn that growth in GDP per capita has not been led by natural resources alone. While some fast-growing countries are natural-resource rich, their growth cannot be explained by the resource boom alone. For example, Nigeria is known as the largest oil exporter in Africa, but its growth in agriculture, manufacturing, and services is either close to or higher than overall growth in GDP per capita. In fact, Nigeria's industrial growth is driven by manufacturing not oil (whose annual growth rate is negative in constant prices); at current prices the share of mining in GDP fell by more than 20 percent between 2000 and 2012 having been replaced by services. The country's recent national account rebasing further confirms that its recent growth is not led by oil exports, as the newly discovered 89 percent of GDP comes from economic activities outside oil and mining. Ghana found oil in 2007 and started to export oil only in 2010, while its persistently stable economic growth started long before the oil discovery. Although it is a diamond exporter, Botswana's recent growth also does not seem to be led by diamond exports, since the mining GDP growth rate is negative. On the other hand, there are resource-rich countries with poor growth performance, such as the Democratic Republic of the Congo (DRC), Gabon, Guinea, and Sudan; two of those countries are in the slow-growth group and growth rate in DRC is at the continental average (Table 2.2, column 1).

Finally, a number of countries are less dependent on natural resources and have done very well. For example, Ethiopia is one of the three best-growth performers; Rwanda, Tanzania, and Uganda are among the seven good-growth performers; and Burundi, Burkina Faso, and Lesotho are among the other fast-growth performers in Table 2.2.

Fact 3: The Share of Manufacturing Exports in Total Exports Is Growing

Table 2.3 shows trade data in constant prices for 15 of the 17 fast-growth African countries. We can see that among the 15 countries, there are 13 in which growth in total goods and services exports is higher than the growth of GDP. This export growth cannot be explained by natural resources and the commodity price boom alone. Among the 17 fast-growing African countries are five that depend heavily on natural resource exports. However, for quite a few countries, such as Ethiopia, Ghana, Rwanda, Mozambique, Tanzania, and Uganda, natural resources and other primary commodity exports are a smaller share of GDP. Total exports of goods and services are also growing rapidly for those countries. For some natural-

resource-rich countries, such as Botswana and Nigeria, the share of natural resource exports in total exports has fallen in recent years.

Table 2.3 Growth in trade at current and constant prices for the 17 fast-growth African countries (2000–2012 annual average, %) and share of net exports in GDP (2000 and 2012, %)

	Growth rate:							Share of net exports in GDP, current price	
	GDP pc	GDP		Total exports		Total imports			
Country	Constant price	Current price	constant price	Current price	constant price	Current price	Constant price	2000	2012
Best-growth performers									
Angola	8.0	27.3	11.7	24.3	41.5	22.4	39.3	27.6	17.6
Ethiopia	6.4	16.2	9.4	17.1	10.2	18.8	11.8	-12.2	-18.1
Nigeria	6.2	17.5	8.2	18.3	na	18.6	na	32.1	32.6
Good-growth performers									
Rwanda	5.4	14.7	8.1	20.7	13.4	18.1	12.9	-18.2	-20.4
Mozambique	4.8	11.4	7.7	14.7	13.7	15.2	8.3	-20.5	-40.5
Sierra Leone	4.8	11.1	8.1	15.9	10.5	13.7	10.2	-15.7	-37.4
Chad	4.4	18.9	8.0	30.8	42.5	17.7	5.2	-17.8	-12.1
Tanzania	4.0	9.3	7.0	16.1	13.3	18.4	17.1	-6.8	-17.8
Ghana	3.8	15.5	6.5	19.1	na	18.6	na	-11.5	-10.4
Uganda	3.6	12.1	7.2	20.3	14.0	17.1	10.8	-11.6	-14.4
Other fast-growth countries									
Namibia	3.3	12.0	4.8	13.0	5.0	13.9	8.0	-3.7	-10.1
Lesotho	3.3	12.0	4.1	11.1	7.3	9.3	3.9	-99.9	-61.6
Burundi	3.2	13.9	6.7	15.9	10.2	20.7	19.5	-12.5	-31.2
Botswana	3.1	9.0	4.2	6.9	1.0	11.6	5.7	11.7	-5.5
Zambia	3.0	18.7	5.9	24.2	10.3	17.2	9.3	-13.9	3.1
Burkina Faso	2.8	13.1	5.8	22.4	15.5	15.8	9.3	-16.0	-6.8
Congo, Dem. Rep.	2.7	11.7	5.7	25.8	5.2	27.4	7.0	1.4	-10.8

Sources: GDP data from UNSD (2014) and trade data from WDI (2014

Notes: GDP = gross domestic product; pc = per capita; na = not available. Given that for two countries trade data in constant value are not available, we report trade growth rate in both current and constant prices. For the purpose of comparison, we also report growth rate in GDP in current and constant prices.

So what are these countries exporting? Table 2.4 indicates that the manufacturing sector in developing Africa is starting to grow. Between 2000 and 2010, the share of manufacturing exports in goods and services more than doubled from 10 percent to 23 percent; and if we exclude a handful of oil exporters, the share rises to 32 percent. These numbers are not driven by just a few countries; quite the opposite, they are based on a group of 34 countries in developing Africa. They are also not driven by one or two products; the range of manufactured exports varies from labor-intensive activities, like textile and shoe manufacturing, to capital-intensive activities, like petroleum refining.

Table 2.4 Manufacturing exports as a share of total exports: All of Africa south of the Sahara and developing Africa south of the Sahara

Variable	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1. Manufacturing exports (millions of USD)											
SSA Developing	6,750	10,172	10,426	13,695	16,729	20,773	31,332	30,822	36,572	33,645	56,419
SSA All	32,334	33,683	30,937	44,427	53,736	64,285	80,736	83,531	96,346	76,457	110,781
Difference	25,584	23,510	20,512	30,731	37,007	43,511	49,404	52,709	59,774	42,812	54,362
Of which:											
Mauritius	1,460	1,491	1,722	1,798	1,869	1,364	2,083	1,970	1,999	1,695	1,429
South Africa	17,396	20,307	17,166	25,154	32,235	36,546	40,793	48,380	54,743	38,261	49,708
2. Goods and services exports (millions of USD)											
SSA Developing	57,008	53,309	56,537	68,449	76,487	92,943	128,770	133,398	174,315	121,357	174,553
SSA All	118,253	111,557	117,547	143,617	171,259	210,721	265,772	303,339	374,129	278,185	368,882
Difference	61,244	58,248	61,010	75,168	94,772	117,778	137,002	169,941	199,814	156,827	194,329
Of which:											
Angola	8,183	6,737	8,535	9,709	13,776	24,286	33,364	46,181	65,742	41,563	51,473
Chad	234	251	252	674	2,252	3,260	3,532	3,844	4,420	3,252	3,927
Liberia	138	147	191	374	124	129	186	239	292	176	248
Libya	12,078	9,054	9,169	15,011	21,117	29,230	40,275	48,510	62,780	0	0
Sudan	1,959	1,503	2,069	2,617	3,810	5,095	6,833	10,046	13,139	8,487	12,958
Sierra Leone	115	85	107	193	239	290	318	337	339	331	433
Mauritius	2,813	3,106	2,947	3,180	3,450	3,761	4,009	4,509	5,103	4,326	5,101
South Africa	37,034	35,695	36,578	46,900	57,890	67,644	78,318	90,077	98,005	77,557	99,399
3. Manufacturing exports as a share of goods and services exports excluding oil exporters (%)											
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
SSA Developing	11.8	19.1	18.4	20.0	21.9	22.4	24.3	23.1	21.0	27.7	32.3
SSA All	27.3	30.2	26.3	30.9	31.4	30.5	30.4	27.5	25.8	27.5	30.0
4. Manufacturing exports as a share of goods and services exports including oil exporters (%)											
SSA Developing	10.0	16.4	15.4	16.7	17.3	16.5	18.1	15.9	14.2	19.2	23.2

Source: UNSD (2013) for 1. Manufacturing exports and World Bank (2014) for 2. Goods and services exports.

Notes: SSA = Africa south of the Sahara. Countries not listed in the table and included in the sample are Benin, Burkina Faso, Botswana, Central African Republic, Cote d'Ivoire, Cameroon, Ethiopia, Gabon, Ghana, Gambia, Kenya, Madagascar, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Tanzania, Togo, Uganda, Zambia, and Zimbabwe.

Fact 4: The Net Contribution of Trade to Growth Is Small

However, the overall contribution of trade to growth remains relatively small. For most countries with exports growing faster than GDP, imports also grow more rapidly than GDP, indicating that the net contribution of trade to GDP growth is much smaller. Indeed, as shown in Table 2.3, the net contribution of trade to growth, measured by an increasing (declining) share of net exports (imports) in GDP between 2000 and 2012, is negative for 13 of the 17 fast-growing countries, and is positive only in five countries: Burkina Faso, Chad, Ghana, Lesotho, and Zambia. Thus, the role of exports in Africa's recent growth should not be overstated.

Fact 5: Growth Is Led by Domestic Demand

In Table 2.5, we show that from the expenditure side, domestic demand (rather than net exports), which is final consumption plus gross capital investment, accounts for the bulk of GDP growth. In addition, investment demand seems to be more important than final consumption in growth; in 15 of the 17 countries the share of capital investment in GDP rises in this period. Among these 15 countries, there are 11 countries in which the share of final consumption in GDP falls in this period. Table 2.5 is consistent with the idea that the domestic market is still the dominant destination for most agricultural and manufactured products and that investment has become increasingly important. Together with the increasing contribution of services to growth, the role of the domestic market in growth is expected to be more important than international markets for the near future in African growth.

Table 2.5 Share of final consumption, investment, and net exports in GDP at current prices for the 17 fast-growth African countries (2000 and 2012)

		Share in GDP:					
	Growth rate	Final consumption		Gross capital formation		Net exports	
Variable	GDP pc	2000	2012	2000	2012	2000	2012
Best-growth performers							
Angola	8.0	60.4	70.4	12.8	11.7	26.8	17.9
Ethiopia	6.4	89.0	85.0	23.1	33.1	-12.1	-18.1
Nigeria	6.2	60.9	68.5	7.0	12.9	32.1	18.6
Good-growth performers							
Rwanda	5.4	105.2	97.6	13.4	22.8	-18.6	-20.4
Mozambique	4.8	89.5	93.2	31.0	48.3	-20.5	-41.5
Sierra Leone	4.8	110.3	113.3	11.0	24.1	-21.3	-37.3
Chad	4.4	94.5	85.6	23.3	26.5	-17.8	-12.1
Tanzania	4.0	89.9	78.4	16.8	39.4	-6.8	-17.8
Ghana	3.8	94.4	79.5	24.0	30.9	-18.4	-10.4
Uganda	3.6	92.0	91.1	19.5	24.6	-11.4	-15.6
Other fast-growth countries							
Namibia	3.3	86.6	86.5	17.1	23.4	-3.7	-9.9
Lesotho	3.3	158.5	129.7	41.3	31.8	-99.9	-61.5
Burundi	3.2	107.1	100.1	2.8	28.4	-9.9	-28.5
Botswana	3.1	58.7	71.1	29.6	34.4	11.7	-5.5
Zambia	3.0	96.5	72.1	17.4	24.7	-13.9	3.2
Burkina Faso	2.8	99.4	79.0	16.8	27.8	-16.1	-6.8
Congo, Dem. Rep.	2.7	96.8	85.3	1.4	26.5	1.7	-11.8

Source: UNSD (2014) and World Bank (2014).

Notes: pc = per capita Final consumption expenditure + gross capital formation + net exports = gross domestic product (GDP) in current price.

Fact 6: Growth Has Been Accompanied by Structural Change

Using the most comprehensive dataset available on employment shares for a wide range of countries, McMillan and Harttgen (2014) have shown that the share of labor employed in African agriculture has

fallen rapidly in recent years; the declines seem to be more rapid in countries with faster agricultural productivity growth.

The coverage of agricultural employment shares in Africa in World Development Indicators is sparse for African countries. However, World Development Indicators does include agricultural value-added per worker in constant 2005 US dollars, agricultural value-added in constant 2005 US dollars, and the total labor force for a large number of African countries. Thus, for purposes of consistency with the data in the rest of the paper, we compute agricultural employment shares in the following way. We first obtain the total labor force in agriculture as the inverse of agricultural value-added per worker times one over agricultural value-added. We then compute the employment share in agriculture as the labor force in agriculture divided by the total labor force. We then compute measures of structural change following McMillan and Rodrik (2011). Since it is impossible to further disaggregate nonagricultural worker data at the subsector level, we consider only agriculture and nonagriculture in this exercise.[3]

Obviously, nonagriculture includes various economic activities with a wide range of productivity (McMillan and Rodrik 2011). Even with such heterogeneity within nonagriculture, labor productivity measured by GDP per worker is consistently higher in nonagriculture than in agriculture across African countries. Thus, the contribution of structural change to growth through the reallocation of labor from agriculture to nonagriculture is significant—accounting for 25 percent of recent growth in output per worker for the developing countries in SSA as a whole (Table 2.6, last row), a result comparable with McMillan and Harttgen (2014).

Table 2.6 Productivity growth decomposition: contribution of within-sector growth and structural change (annual average in 2000–2012, %)

Variable	Growth in GDP per worker	Within-sector growth		Growth due to structural change
		Agriculture	Nonagriculture	
Best-growth performers				
Angola	6.5	0.8	4.0	1.8
Ethiopia	5.0	1.3	2.9	0.7
Nigeria	5.7	2.9	2.9	-0.1
Good-growth performers				
Rwanda	4.6	0.8	3.5	0.3
Mozambique	4.7	1.0	2.7	1.0
Sierra Leone	2.8	0.8	1.5	0.5
Chad	1.4	0.0	1.4	0.0
Ghana	3.3	1.8	1.3	0.3
Tanzania	3.8	0.6	1.8	1.4
Uganda	3.5	-0.1	4.4	-0.8
Other fast-growth countries				
Namibia	2.2	0.1	1.1	1.1
Lesotho	3.6	-0.2	4.7	-0.8
Burundi	-0.6	0.1	-2.8	2.0
Botswana	1.9	0.0	1.4	0.5
Zambia	3.0	0.2	2.3	0.6
Burkina Faso	2.6	1.6	1.9	-1.0
Congo, Dem. Rep.	1.4	-0.7	2.0	0.0
Africa south of the Sahara	5.7	0.9	3.4	1.4

Source: UNSD (2014) and World Bank (2014).

Notes: Labor force data for Chad are not available until 2006. According to the recent national account rebasing, Nigeria's nonagricultural gross domestic product (GDP) is significantly underestimated in recent years. Plus there is the problem of the data for the share of agricultural workers in total labor force, which seems to be too low, causing the relative labor productivity in agriculture to be higher than in nonagriculture in recent years. Thus, the results for Chad and Nigeria should be treated with caution.

[3] We cannot use the Food and Agriculture Organization (FAO) data to compute agricultural employment shares since FAO reports agricultural gross output (constant value), instead of agricultural value-added. This can be sufficient for studying only the agricultural sector, but since our goal is to make comparisons across sectors, these data cannot be used.

Fact 7: Growth Has Been Accompanied by Growth in the "In-Between" Sector

How do we know this? National accounts do not include information about the in-between sector separately (and as we have seen in the cases of Nigeria and Ghana, it is often left out altogether), so we do not directly observe the growth of this sector. However, we do know that in the majority of African countries the employment share in agriculture has declined significantly (McMillan and Harttgen 2014). We also know that large-scale modern manufacturing has not yet expanded significantly in any African countries (McMillan, Rodrik, and Verduzco 2014). Thus, it has to be the case that the in-between sector is absorbing the majority of these workers when economies are growing. We are only beginning to understand the composition of employment in these activities because they tend to take place in the informal sector. However, evidence from Nigeria, Rwanda, Tanzania, and Zambia indicates that small-scale manufacturing and production-related services often account for a substantial share of in-between activities.

Implications for Understanding Growth in Modern Africa

The stylized facts laid out in this section reveal a number of important characteristics of the recent growth in SSA. Contrary to popular perception, such growth has not simply been driven by natural resource exports. Real changes are taking place that involve a smaller share of the population reliant on agriculture as a source of income and more people who earn a living from nonagricultural activities. Different from Asian countries, these changes have so far not been driven by a large expansion in formal manufacturing whose products are destined for export. Instead, for the most part, the economies of SSA are dominated by small and medium-size enterprises. The activities of such enterprises are diverse and range from food processing and furniture production to financial and telecom services. The markets for these products and services are primarily domestic.

The stylized facts imply that a typical Asian model in which growth is driven by labor-intensive manufacturing for export is not that helpful for thinking about Africa's recent growth. Instead, we need a new framework for thinking about growth in Africa that incorporates these stylized facts. We lay out the conceptual foundations for such a framework in the following section.

3. A CONCEPTUAL FRAMEWORK ADAPTED FROM LEWIS

Lewis (1954) describes the process of economic development for economies with three characteristics: (1) labor productivity differs in "modern" and "traditional" sectors such that the modern sector grows by recruiting labor from the traditional, (2) unskilled labor is paid more in the modern sector than in the traditional sector for the same quantity and quality of work, and (3) unskilled labor is initially abundant in the sense that at the current wage level much more labor is offered to the modern sector than that sector wishes to hire.

After Lewis's 1954 seminal article, the dual-economy model has come in a wide range of specifications with different assumptions. In a typical neoclassical dual-economy model, Lewis's open system is replaced by a closed system, which emphasizes the general equilibrium interactions of the traditional and modern sectors (Ranis and Fei 1961). Growth in the traditional sector, which is replaced by the agricultural sector, becomes necessary as at a given level of agricultural productivity, increased food demand by the industrial sector causes the real wage rate to rise (Jorgenson 1967), and thus growth becomes hard to sustain (Ranis and Fei 1961).

Whereas the typical subsistence sector Lewis described in 1954 may be less important for understanding Africa's economic growth and transformation today, the basic principles of the Lewis framework that emphasize economic transformation as an open system are still viable; in other words, the notion of a dual economy is still relevant. The question is: based on what we know about current-day Africa, how can we best describe and conceptualize this dual economy? Rodrik (2014b), closely following Lewis's terminology, argues that the movement of labor from low-productivity "traditional" activities to high-productivity "modern" activities that have escalator properties provides a "short-cut" that developing countries have used for rapid structural transformation.

For the Asian miracle countries, the modern activities consisted primarily of labor-intensive manufacturing for export. However, the nature of global manufacturing is constantly evolving so that in many developing countries modern manufacturing has increasingly become part of global value chains (Timmer et al. 2014). While participation in global manufacturing value chains can provide employment opportunities to low-skilled labor in developing countries, it also increases specialization in industrialization—many low-income developing countries contribute a small component of low-skilled activities to the final manufactured products whose value chains are governed by firms in the advanced countries. The changing nature of these relationships makes it less clear how it is that manufacturing can lead the transformation of traditional economies into mature industrialized economies.

In addition, African economies are changing rapidly and their current economic structures have become much more diverse and heterogeneous than before. Between the economic activities that can still be described as subsistence or traditional and modern manufacturing factories that become part of global value chains, there are various levels of productivities across many different types of agricultural, industrial, and service activities. With increases in agricultural productivity, rapid population growth, and urbanization, the role of self-employment and small and medium-size enterprises is increasingly important. Thus, Africa's growth cannot be explained without considering the contribution of such in-between activities.

In many African countries, enterprises in the in-between economy produce similar goods and services as the formal sector. That is, dualism does not occur along sectoral lines—for example, agriculture versus industry. Indeed, labor productivity in many of those in-between activities is lower than their formal counterparts, while the employment generated by such activities dwarfs that of their often much larger formal counterparts. Thus, as large amounts of labor exit from agriculture, as Filmer and Fox (2014) predict, and when many of those people will end up in the in-between sector, structural change led productivity growth will continuously come from the expansion of these in-between activities, an important fact characterized the recent structural change in Africa.

Thus, to better describe the dualism of today's African economies, it is not enough to consider the productivity differences across sectors, for example, agriculture and nonagriculture; nor is it sufficient to divide the economy by traditional and modern. The coexistence of small and large enterprises within a given sector for producing seemingly similar products and services at different productivity levels clearly indicates that dualism is associated with a series of constraints that lead enterprises to remain small and often informal. Facing such constraints, entrepreneurial individuals take actions to better their lives of their own accord rather than waiting for constraints to be relaxed.

This kind of duality has been documented by La Porta and Shleifer (2014) and Sonobe, Akoten, and Otsuka (2009); that is, small and medium-size enterprises primarily serve the local market while many of the larger firms serve the international market. The shoes made by the small firms in Ethiopia, for example, are sold to locals, whereas the shoes made by the large automated firms in Ethiopia are exported to the United States and Europe. And in a description of the furniture industries in Kenya, Madagascar, and Mauritius, La Porta and Shleifer (2014) make the observation that there is a difference in both price and quality between the furniture made by small informal firms and that made by the large formal firms.

The study by Sonobe, Akoten, and Otsuka (2009) underscores the dynamic nature of the small-scale shoe sector in Ethiopia. This industry comprises more than 1,000 firms the majority of which are microenterprises. Most of the shoes the microenterprises produce are sold on the domestic market while a few larger firms export. In the early 2000s, the industry was hit by competition from Chinese shoes that flooded the market, plunging the industry into a slump. According to Sonobe, Akoten, and Otsuka (2009), the industry rallied together and through quality upgrading took back the market. Although the productivity improvements were led by some of the larger firms with more educated owners, the smaller firms learned from the larger ones, and the industry is flourishing today.

Based on all of this evidence, it might be more helpful from an analytical point of view to classify modern economic activities in an African country based on the extent to which goods are tradable in international markets. By dividing the modern economy into a set of small-scale enterprises that operate primarily in domestic markets and a set of larger firms that operate in international markets, we can broaden the set of activities that take place in either of the two parts of the economy. Thus, rather than focusing on manufacturing versus agriculture as the modern versus traditional sector of the economy, we now consider the closed and open subcomponents of the modern economy, both including manufacturing, agriculture, and services. This distinction also highlights the quite different roles of the domestic and international markets in the growth and transformation process.

Against this understanding of dualism in modern African economies, we consider a framework that allows us to better understand the two parts of the economy with minimum departure from neoclassical economics. The framework that we think best helps us to understand Africa's dualism consists of a closed and an open economy. Whereas in reality neither sector is completely closed or open, structuring the framework in this way enables us to narrow in on a few key aspects of Africa's economies that we think are important.

In what follows, we will sometimes refer to the in-between economy as the closed economy and often use these terms interchangeably. In addition, the reason we did not begin the paper with "informal sector" as the in-between is because informality is typically associated with backward and unproductive firms. By contrast, our in-between sector is dynamic and transitional and part of it is a key component of the development process. Additionally, informality has many different definitions and a discussion of these issues would detract from the central purpose of this paper.

Key Features of Modern Africa's Dual Economies

1. We define the in-between economy—including mainly micro, small and medium enterprises that produce only for domestic markets—as the closed modern economy (for short, we call it the closed modern) and the larger enterprises in the formal economy as open to international trade (the open modern).

2. While for the closed modern international trade is unlikely to happen, trade does happen within it, that is, we do not consider farmers and other small individual producers in the closed modern to be subsistence in nature (that is, producing only for home consumption); rather they produce for the domestic market.
3. Productivity differs across activities in the closed modern, and is generally lower than those in the open modern. Among economic activities of the closed modern, we assume that productivity is relatively high in activities whose product is income elastic in domestic demand, while productivity is low in activities whose products are income inelastic in demand. That is to say, productivity differs across activities in the closed modern and such difference is an outcome of changing patterns of domestic demand, which can be reflected by differences in final goods prices.
4. The open modern is the collection of current formal economic activities that can be agricultural such as cooperative farms or export-oriented food product value chains, modern manufacturing companies, or modern service sectors including banking, modern hotels, supermarkets, and so on.
5. The open modern is highly integrated with the global market—that is, the technology and hence productivity in the open modern is at or close to international standards. Goods can be produced for international markets as export. When such goods are imported, domestic producers are typically not competitive unless they are protected.
6. There are nontradable activities in the open modern and they are mainly modern services. When output of such activities are not traded in international markets it primarily due to the nature of their activities rather than because the firms are not productive.

The dual economy is thus described by the coexistence of a closed and an open modern within a country. In fact, this type of dualism—that is, the coexistence of a closed and an open parts of an economy—was common in the early industrialization process in other countries where governments deliberately separated economic activities as export oriented or import substitutable by a set of industrial policies including trade, financial, taxation, and many more. That is to say, industrial policy was used not only for promoting industrialization but also to serve as a barrier for separating economic activities that might not yet be ready to compete in international markets from those destined for international markets. One reason for this type of industrial policy was to ensure that activities in the closed modern did not pull down the quality of the products produced by firms in the open part of the economy.

There are plenty of examples of this type of separation of economic activities from Asia's early industrializers. Policies that ensured infant manufacturing and other industrial sectors to be able to grow and eventually to join international competition are the good examples. In this process, production closed to international competition is often for domestic markets typically with lower quality and commanded lower prices.

One such example is the development of Korea's television (TV) industry (Harvie and Lee 2003). In order for the color TV industry to get into international markets and hence to meet international quality standards, South Korea's government did not allow color TVs to be sold domestically until 1980. In fact, color TV channels started to operate in Korea only in 1981 although such TVs had been exported since the 1970s; prior to 1981, only black-and-white TVs were sold domestically. Harvie and Lee mention several other examples in their paper, including phonographs, portable telephones, mink coats, and so on, that were produced only for export. They argue that if the government had not actively separated domestic and international markets, the products produced probably would have been of a lower overall quality when the country was very poor. That could have resulted in the mass production of low-quality color TVs that would have been difficult to export.

In today's African countries, the use of industrial policy for separating domestic and international markets is less likely for a variety of reasons that we will not go into in this paper. However, we note that the lack of such policies may be one of the reasons the large scale modern manufacturing sector has been less quick to grow in Africa.

Without a deliberative industrial policy, dualism still exists in African economies—wage rates are high and increasing in the open modern, and the available labor force in the closed part of the economy seems to create little downward pressure on wages in the open modern. In the literature one sees significant efforts to formalize the duality in the labor market. Some obvious reasons for the dual nature of the labor market include institutional factors that keep wages high in the urban formal sector and, related to that, a public sector that acts as a wage setter for the entire formal sector. However, many assumptions about such dualism seem to be less convincing against the reality of modern Africa's wage differentials. In fact, we do not understand why wage rates are so much higher and increasing in the formal economy while many rural workers are leaving agriculture for urban centers—and that phenomenon also puzzled Lewis (1979). Thus, for our framework, we do not focus on how to describe such wage differentials in a structural model—that is, we take no stand on the reasons for this wage differential and simply state it as an observation. The importance of the wage differential in our framework relates to consumption. Middle-class urban residents with relatively high earnings from jobs in the open modern consume many imported goods, while low-income urban residents working in the closed modern as well as the majority of rural residents mainly consume domestically produced goods. Qualities and prices typically differ between these two markets for goods that are often similar in nature.

Of course, there are many manufacturing goods that African countries do not produce but that either are required as intermediates in the production process in both the open and closed parts of the economy, such as fertilizer for farmers, or are consumed as final goods for citizens in both the closed and open economies, such as cell phones. That is to say, the closed modern we describe here is not an autarky. Instead, the emphasis is on the idea that the coexistence of economic activities that produce similar goods for different groups of consumers—exports or domestic markets—is possible. In this way, there is no direct competition and substitution for similar goods produced for the two different modern economies. There are also no regulations that restrict workers from moving out of the closed modern and into the open modern; however, that possibility does not exert downward pressure on wages in the open modern. Again, we emphasize that this is a feature of the dual economies we describe and not something we try to explain or test in this paper.

By separating the closed and open parts of the modern economy within a country, we are better able to understand—at least superficially—the reasons for and the contribution of the growth from the in-between economy. In summary, the in-between economy, which is defined as the closed modern in our framework, provides goods and services to households whose income is also derived from such in-between activities. Growth in this closed modern is less dependent on the direct forces of globalization, i.e., a myriad of rules and regulations that the open modern is subject to do not apply to the closed modern. On the other hand in the open modern, productivity is close or converging to international standards. With such distinction, which also distinguishes our conceptual framework from that of Lewis (1954), it is obvious that the drivers of growth in the close and open modern can be very different, while both economies can lead the economywide growth.

Linkages between the Closed and Open Modern

Here we lay out some important linkages between the closed and open parts of the economy:

1. The first important linkage is through labor mobility. We assume that the supply of labor is fixed in the open modern and additional labor demand in the open modern is met by migration of labor from the closed to the open modern. On the other hand, the additional labor demand in the closed modern is met by labor migration from the traditional economy, which is implicitly included in our framework without giving an explicitly analysis. Following Lewis (1954), we assume that the supply of labor in the closed modern does not create downward pressure on wages in the open modern, and market forces do not ensure the equalization of the marginal product of labor between the two parts of the economy. Again, many possible reasons exist for that, and for now we simply take it as an accurate description of life in low-income African countries.

2. There are also consumption linkages. For example, workers in the open modern may consume goods produced by the closed modern—particularly agricultural goods. We assume that at similar income levels, workers in the open modern do not consume more goods from the closed modern than those working in the closed modern. In other words, the income elasticity of demand for the closed modern's products and services is much lower for the workers in the open modern than it is for those working in the closed modern. Also, we assume that the closed modern produces similar goods to those produced in the open modern at lower prices (and lower quality), and such goods are mainly purchased by consumers in the closed modern.
3. The third type of linkage between the closed and open modern economies is through productivity link. The growth literature is full of models of productivity growth in a closed-economy setting, but those theories seem more suitable for developed countries (for example, research-and-development-led growth in the new growth theory). In our closed modern economy, productivity growth comes from either public investment in infrastructure (which should benefit productivity growth in both closed and open modern) or the use of imported intermediate goods coming from the open modern (i.e., the modern technology is embodied in the imported goods in this case). Thus, productivity growth in the closed modern is treated as an externality that augments its total factor productivity (TFP) (in the first case) or via the use of modern intermediates (in the second case). Examples of the latter case include the use of imported fertilizer and improved seeds that leads to productivity growth in agriculture in the closed modern. Self-discovery and new activities created through the use of modern goods imported through the open modern can also result in productivity growth in the closed modern. For example, the use of mobile phones not only lowers information costs but also induces other innovations in the closed modern. That is, the closed modern can be dynamic and benefits from connections with the open modern.
4. Productivity growth in the open modern follows conventional theory—that is, foreign investment can create new and more productive activities for export or for import substitution, and the expansion of existing export-oriented activities is possible because labor is available from the closed modern. The open modern can play an important role in overall economic growth of the country through its expansion over time. That is, we think of the typical growth strategies discussed in the literature for developing countries as growth strategies suitable for the open part of the economy.

By distinguishing the closed modern economy from the open modern economy, we can now understand that a wider set of strategies is available for the promotion of growth. For example, whereas in the open modern we can continue to implement a growth strategy based on the promotion of exports, in the closed modern, encouraging self-discovery and creative activities may be key. Here the growth promotion policy should help local entrepreneurs grow and also help them eventually move (or graduate) from the closed to the open modern economy.

Our description of the dual economy as consisting of a closed and an open modern sector also helps us understand the trade-offs specific growth strategies entail. For example, increases in public investment to improve fundamentals such as building infrastructure and investing in agriculture should benefit both the closed and open modern economies. However, when such investment is heavily financed by foreign inflows that create real exchange rate appreciation, the nontradable sector in the open modern (modern hotels, real estate, and so on) becomes more attractive for private investment, while the tradable sector, either exported oriented or import substitutable, becomes less attractive to private investors. This is because the real exchange rate appreciation affects export earnings as well as the cost of labor in the open modern.

On the other hand, this type of public investment can benefit the closed modern significantly both through the improvements in roads and other infrastructure and through the creation of more domestic demand—which leads to a more efficient use of resources (including agriculture) in the closed modern. So, although the movement of labor from the closed to the open part of the economy may slow down, growth can continue, led mainly by the expansion of the closed modern, as we observe in Africa's recent economic history.

4. TAKING THE FRAMEWORK TO THE DATA

Our goal in this section of the paper is to make more concrete the ideas we have laid out in the previous sections. To do this, we develop a computable general equilibrium (CGE) model for Rwanda to assess the role of the closed and open modern economies in shaping the country's patterns of growth and structural change. We choose Rwanda because Rwanda possesses many of the features of the economies we have described and its growth has not been dependent on natural resources. Although an open economy exists, it is rather small in comparison with the closed part of the economy, which allows us to better understand the role of the closed modern for growth and transformation in a typical low-income African country.

Rwanda's Recent Economic Performance

As previously noted, Rwanda belongs to the group identified as good-growth performers, together with Mozambique, Ghana, and Tanzania. Rwanda's annual GDP growth between 1999 and 2012 was 8 percent; accounting for annual population growth of 2.5 percent leaves annual growth in GDP per capita still very impressive at 5.5 percent per annum. In fact, Rwanda's postgenocide growth is at a historical high.

Relative to other countries in SSA, Rwanda has a very high population density, is poor in natural resources, and is landlocked. In fact, Rwanda is the country with the highest population density in Africa at 416 persons per square kilometer (in 2012). This makes Rwanda's recent achievements even more impressive. Rwanda's performance is widely believed to have been significantly bolstered by its government's commitment to policy and institutional reform as well as its expenditures on public investment. According to the World Bank's *Doing Business 2014*, Rwanda progressed from 58th to 32nd in the ease-of-doing-business ranking worldwide in recent years and ranks the second highest in Africa after South Africa. Rwanda is also considered to be the second-most-reformed economy in the world over the last five years, as well as being the first in the East African Community by this measure (World Bank 2013).

Rwanda's growth has also been broad-based, leading to rapid reductions in poverty. Based on the *Integrated Household Living Conditions Surveys 2* and *3* (*Enquête Intégrale sur les Conditions de Vie des Ménages*, or EICV2 and EICV3) (Rwanda, National Institute of Statistics 2005/06, 2010/11), the national poverty rate has been lowered by 12 percentage points between 2005/06 and 2010/11. Actually, the achievement of poverty reduction in Rwanda is far more impressive than lowering the national poverty rate, as more than 40 percent of the population still lives below the poverty line in 2011. Thus, the change in per capita real income by income quintile tells a more impressive story about poverty reduction in Rwanda. Between 2005/06 and 2010/11, per capita real income has increased by almost 40 percent for the poorest 20 percent of households, more than 20 percent for the second and third quintiles of households, and slightly less than 20 percent for the fourth quintile of households.

While Rwanda's recent growth is encouraging, the country still faces a number of important challenges. When we look further into the role of structural change in recent growth, we see that the nontradable sectors seem to lead recent growth in the economy. For example, five subsectors of the economy have a growth rate 50 percent higher than the overall GDP growth rate in 1999–2012, and all of those sectors are more or less nontradable. Table 4.1 displays the annual growth rate for those five sectors and their contribution to overall economic growth in recent years.

Table 4.1 The five fastest-growth sectors in the Rwandan economy (1999–2012)

Sector	Annual growth rate (1999–2012)	Share of GDP in 1999	Share of GDP in 2012	Contribution to growth in GDP (1999–2012)
Construction	12.4	6.6	9.3	11.0
Hotels and restaurants	16.9	1.1	1.9	2.4
Transport	14.7	5.2	7.9	10.8
Education	13.4	2.8	6.4	8.1
Other personal services	18.5	0.2	0.9	1.6
Total	13.8	15.8	26.5	33.9

Source: National Account, MINECOFIN (2013).
Note: GDP = gross domestic product.

The nontradable sectors' growth, particularly growth in construction and education, is often the result of investment. Investment as a ratio to GDP has risen from 13 percent in 1999 to 22 percent in 2012. In 2006–2012, the annual average growth rate in investment reached 15 percent, and 77 percent of that investment has been in construction. Part of the construction boom is due to heavy investment in infrastructure, which benefits both the closed and open economies through improvements in transportation.

Although the investment growth rate is impressive, it is dominated by the public sector. The data between 2007 and 2011 show that public investment as a share of total capital formation was 51 percent in 2007 and rose to 64 percent in 2011; that indicates public investment is one of the main drivers of Rwanda's recent growth. The government of Rwanda has increased its tax revenue in recent years, while spending under the government current (noncapital) expenditure account is still more than its tax revenue. Thus, public investment still has to be partially financed through external sources. Indeed, according to available data and measured at constant prices, foreign grants received by the government grew at 8 percent per year over the 2000–2011 period, and has accelerated to 20 percent per year in 2006–2011. Together with the other nonprivate (mainly nongovernmental organization) channels, foreign inflows through nonprivate channels are equivalent to 70 to 96 percent of total capital formation between 2007 and 2011.

In the development literature, until recently, cross-country growth regressions consistently show a negative relationship between foreign aid/capital inflows and long-term growth (Rajan and Subramanian 2011). Rodrik (2008) argues that the overvalued exchange rate, as a result of foreign inflows, is a fundamental reason for this inverse relationship between foreign aid and growth.

In the case of Rwanda, foreign inflows—measured as the deficit in the current account—have grown at more than 15 percent annually. Growth in foreign inflows further accelerated after the debt relief in 2006 with the average annual growth rate reaching 28 percent for the 2006–2011 period. Excluding foreign grants from the current account deficit (foreign grants help to reduce the current account deficit but represent a different type of foreign inflow directly going through the government), the ratio of foreign inflows (measured as trade deficit) to GDP increased from 14 percent in 2006 to 22 percent in 2012 (National Account, MINECOFIN 2013).

While foreign inflows help finance Rwanda's public investment, they can also cause the real exchange rate to appreciate, which negatively affects growth in the tradable sectors; these sectors' relative prices—which are more influenced by international prices—fall against the prices for the nontradable sectors. However, the overvalued real exchange rate that hurts the tradable sectors can actually help the nontradable sectors grow.

Summarizing, Rwanda's recent patterns of growth and structural change combined with the fact that small enterprises dominate the nonagricultural economy make it an ideal case in which to explore the implications of the dual-economy framework we developed in Section 3. Specifically, we adapt the dynamic CGE model and the social accounting matrix (SAM) of Rwanda developed by Diao, Bahiigwa, and Pradesha (2014) to our dual economy framework for the Rwandan economy in 2011.

Structure and Assumptions of the Model

Sectors Included in the Model

Consistent with the new dual-economy framework we laid out in Section 3, in the CGE model we classify the Rwandan economy into two economies—one that is closed to international trade and one that is open. We did not distinguish a traditional sector in the CGE model for the reason of simplification, and consider any traditional activity as part of the closed economy. Thus, besides three nontradable agricultural sectors that are the main part of the closed economy, we include a manufacturing and a service sector in the closed economy.

In the open part of the Rwandan economy there are three tradable agricultural sectors (either exportable or import substitutable), six manufacturing sectors, and four modern service sectors. Among the six manufacturing sectors, mining and processed food exports (to which the two most important export commodities, coffee and tea, are the main raw material inputs) are exportable manufacturing, while the other four, including importable processed foods, other manufactured consumption goods, intermediate goods, and investment goods, are import-substitutable manufactures.

In the four modern services, one is exportable and one is import substitutable, and the other two (including public services) are nontradable. These sectors correspond to three of the five fastest-growing sectors in the Rwandan economy discussed previously. For the other two fast-growing sectors in Table 4.1, we define construction as "nontradable industry sector" in the open economy, and personal services as "nontradable services" in the closed economy.

Corresponding to the closed and open parts of the Rwandan economy are two households, one belonging to the closed economy and one to the open economy. For convenience, we simply call the households in the closed economy closed households, which includes all rural households and the urban households working in the in-between nonagricultural sectors; the remaining households are classified as open households.

The closed households own agricultural land, agricultural labor, unskilled labor, and closed capital, while the open households own skilled labor and open capital—that is, there are two types of capital defined according to the two parts of the economy, and capital is mobile only across sectors within each part of the economy, not between the closed and open economies. The closed households mainly consume goods and services produced in the closed economy. Two goods are exceptions: "other manufactured goods" and "public services" are produced in the open economy but also consumed by closed households because they are not available in the closed economy. Besides livestock, one of the three nontradable agricultural goods, which is produced by the closed economy and consumed by households in both economies, the open households consume only goods and services produced in the open economy.

Intermediate Inputs

Although only two sectors in the open economy and one sector in the closed economy produce goods for both types of households, products of most sectors in both economies are used as intermediate inputs by the other economy. For example, agricultural production in the closed economy uses manufactured intermediate goods, such as fertilizer, as inputs, and food processing for export in the open economy uses the closed economy's agricultural products as inputs.

The Government and the Public Sector

The model also includes the public sector as a services provider, which hires skilled labor from open households, together with the use of intermediates, to produce public services in the open economy. The produced public services are one of the two goods produced in the open economy but consumed by both types of households. The government is also included in the model, and it collects income taxes and receives foreign grants and then spends such income on public services (which are the output of the

public sector), income transfers to households, and infrastructure investment. There is also a foreign sector in the model. Besides foreign grants that get transferred to the government, the foreign sector finances capital investment directly. About 25 percent of such investment is assumed to be foreign private investment invested directly in the three tradables in the open economy. Returns from foreign private investment go abroad. The remaining 75 percent of foreign investment augments the private capital employed in the open economy's manufacturing and services, and returns from newly formed capital through such foreign investments go to households in the open economy.

Labor and Land

The recent household survey data (EICV3) show that about 75 percent of the total labor force works in agriculture, and the model is structured in a similar way. EICV3 does not specify whether an occupation is formal or informal, and we group different types of occupations classified in EICV3 further based on detailed sector and consumption information of EICV3. This results in three types of labor in the model: (1) agricultural labor that is employed in the closed economy's agricultural production only; (2) unskilled labor that is employed in tradable agriculture in the open economy and nontradable, nonagriculture in the closed economy; and (3) skilled labor that is employed in all the sectors in the open economy.

Only one subsector—nontradable industry (i.e., construction)—in the open economy hires both skilled and unskilled labor. In all other sectors, only one type of labor is employed. Land is used in agricultural production, while closed and open capital is employed, respectively, in the closed and open economies.

Unskilled labor accounts for 18 percent of the total labor supply, of which 2.5 percent works in tradable agriculture and 15.5 percent works in the closed economy's nonagricultural activities. Skilled labor (including public-sector employees) accounts for 7 percent of the total labor force and is all hired by the open economy.

We take the growth rate of the labor supply and land expansion as exogenous. We assume that agricultural labor grows at 2 percent per year, unskilled labor at 4 percent, and skilled labor at 3 percent, such that the total labor supply grows at 2.5 percent, a growth rate consistent with Rwanda's population growth rate in recent years. The higher growth rate of the unskilled labor supply relative to the agricultural labor supply delivers a declining employment share in agriculture and a relatively stagnant share of employment in the open economy, similar to what we have observed in Rwanda and elsewhere recent years.

Capital and Investment

Private investment is financed through household savings and foreign direct investment, while public investment is financed through government savings (which can be negative) and foreign grants received by the government. Private investment leads to capital accumulation, and public investment results in productivity growth (explained in 8). Thus, capital accumulation as the result of private investment is an endogenous process. However, newly formed capital cannot automatically be distinguished as closed or open capital. Here, we need to define an allocation rule such that both closed and open capital will grow through investment; open capital can grow more rapidly than closed capital consistent with the facts on the ground. To influence the allocation of capital while maintaining endogenous growth of the total capital stock, we assume that part of capital is sector specific, and its growth rate is exogenous. Specifically, we choose the growth rate for capital employed in the nonagricultural tradable sector exogenously, while allowing the growth rate for capital used in the nonagricultural nontradable sector to be endogenous. These assumptions deliver higher rates of capital accumulation in the open economy, 4.4 to 4.5 percent per year, than in the closed economy, where capital grows at a rate of 2.4 to 3.7 percent per year.

Labor Productivity and Wages

Based on the actual data used to structure the distribution of labor across sectors, it is obvious that sectors in the closed economy are much more labor intensive than those in the open economy, which also implies that value-added per worker in the closed economy is much lower than in the open economy. Since 75 percent of the labor force is working in agriculture and since agricultural GDP is about one-third of total GDP, labor productivity, measured by agricultural GDP per worker in agriculture, is lower than in any other sector of the economy.

Roughly speaking, the relative labor productivity (normalized by the average labor productivity of the whole economy) is 0.43 for agriculture, 2.04 for nonagriculture in the closed economy, and 4.93 in the open economy. Differences in labor productivity also have an impact on the wage rate. According to the data processed from EICV3, more than 80 percent of agricultural labor is unpaid small farmers whose main income is captured by the returns to land in the model. This implies that the average wage rate in agriculture is extremely low, equivalent to only 15 percent of the wage rate for unskilled labor and 7 percent of the wage rate for skilled labor. The unskilled labor wage rate is equivalent to about 50 percent of the skilled labor wage rate. We calibrate the initial levels of the wage rates using this information; however, in the model wage rates are determined endogenously as are the returns to land and capital.

With such large gaps in wage rates between agriculture and nonagriculture and between the closed and open parts of the economy, when labor moves from agriculture to nonagriculture even in the closed economy, labor productivity will rise significantly as will the welfare. While the model does not specifically define poor and nonpoor households, it is obvious that most poor households will be in the closed household group, which includes most rural households and urban households depending on informal activities as main sources of income. Growth in the closed economy through labor movement from agriculture to nonagriculture positively affects the welfare of the closed household group, which implicitly implies greater benefits for poor households in Rwanda.

Public Investment and Productivity

The dynamics in the model come from two sources: (1) capital accumulation through private investment, which has been discussed above in 6; and (2) productivity growth through public investment. Many factors can lead productivity growth in either a closed- or an open-economy setting. For example, Gollin and Rogerson (2014) develop a closed-economy model with three geographic locations: (1) cities where manufacturing takes place, (2) rural areas that are relatively close to cities, and (3) remote rural areas. Based on that model, they find that improvements in transportation infrastructure (which is a typical public investment) have a significant effect on the population living in remote rural areas by making it easier for them to move from subsistence agriculture into manufacturing; the share of workers living in close-by rural locations remains virtually unchanged.

In our model, productivity growth is an outcome of public investment. We set the elasticity of public investment to TFP growth equal to 0.28; this was calculated using data from Rwanda on public spending and productivity growth for the past 15 years (Diao, Bahiigwa, and Pradesha 2014).

Relative Prices, the Real Exchange Rate, and Productivity

We know from previous work that an important relationship exists between the real exchange rate and growth (see, for example, Rodrik [2008] and Johnson, Ostry, and Subramanian [2010]). Thus, we take into account the effect of the real exchange rate on productivity growth in the open economy's tradable sectors. The real exchange rate is measured as the domestic producer price index, an endogenous variable in the model, over the international price index, which is exogenous. Following the literature, if the real exchange rate depreciates, the productivity growth rate in the open economy's tradable sector is assumed to increase. An elasticity of 0.72 is chosen for the relationship between changes in the real exchange rate and productivity. For example, if the real exchange rate depreciates by 10 percent, the TFP growth rate for the tradable sectors in the open economy rises by 3.2 percent, while for the nontradable sectors of the

open economy and all the sectors in the closed economy, the productivity growth rate remains at 3 percent—this is because it is solely determined by public investment. In other words, we assume that the real exchange rate does not directly affect productivity growth in the closed part of the economy.

On the other hand, when the real exchange rate appreciates, the TFP growth rate in the open economy's tradable sectors is negatively affected. For example, if the real exchange rate appreciates by 10 percent, the TFP growth rate falls to 2.78 percent in the open economy's tradable sectors and remains at 3 percent for all other sectors.

In addition, when the real exchange rate depreciates, imported intermediates become more expensive and demand for such products may fall. In that case, the depreciation of the real exchange rate can have a level effect on productivity, but it will not affect the growth rate of productivity. Moreover, these general equilibrium effects are endogenous to the model.

Growth Scenarios

Based on the model structure and assumptions discussed above, we are now ready to consider two alternative growth scenarios based on different assumptions about the growth in foreign inflows for the period 2012 to 2025. The model is calibrated using 2011 as the base year.

The two scenarios are developed to help us understand patterns of growth and structural change in Rwanda using the dual-economy framework we describe in Section 3. We focus specifically on the role of foreign grant inflows in shaping the patterns of growth and structural change in the simulations. This is because at this stage in Rwanda's development, tax revenues are insufficient to cover Rwanda's public investment plans. That is expected to change in the medium to long run, but since we are concerned with the near future, we ignore them in our simulations.

In the first scenario, foreign grants received by the government are assumed to grow continuously at 15 percent per year, a growth rate similar to that seen in recent years; we call this scenario the "more-foreign-grant-dependent" scenario. In the second scenario, the growth rate in foreign grant inflows falls to 6.5 percent per year, and the ratio of foreign inflows to GDP falls over time, that is, foreign grant inflows continuously grow but the growth rate in scenario two is much more modest than that in recent years. We call this the "less-foreign-grant-dependent" scenario.

As noted above, the growth rates in labor and land are exogenous to the model and are the same between the two scenarios. In addition, the elasticities of growth to TFP with respect to growth in public investment and changes in the real exchange rate are the same in both scenarios. Thus, there are two channels through which foreign inflows influence growth in our model. First, increased foreign grant inflows facilitate economic growth by financing additional public investment that leads to more capital accumulation and higher productivity growth. Second, foreign inflows can negatively affect the open economy's productivity growth if they lead to the appreciation of the real exchange rate. On net, the impact of foreign inflows on growth depends on which force dominates.

Table 4.2 shows the results of the simulations. One can see that, based on the parameters used in the model and the current economic structure calibrated from the data, the impact of different increases in foreign grant inflows on overall GDP growth is rather modest, that is, the difference between the two scenarios' GDP growth rates is less than 0.1 percentage point, while the difference in the assumed foreign grant inflow growth rates is considerable; the growth rate of foreign inflows in scenario one is 2.5 times that in scenario two. Put differently, the positive and negative effects of foreign grant inflows on economywide growth seem to balance each other out.[4]

[4] We should emphasize that the magnitude of the trade-off effect of foreign inflows through public investment and real exchange rate on overall growth is an empirical question. We did not purposely target such a similar growth result in total GDP when the levels of foreign inflows differ considerably.

Table 4.2 Growth results of the model, average annual growth rate (2013–2025)

Sector	More dependent on foreign grants	Less dependent on foreign grants
GDP	6.64	6.56
Agriculture	5.13	5.33
Industry	7.70	7.35
Manufacturing	5.03	6.25
Services	6.55	6.86
GDP, closed economy	6.61	6.51
Nonagriculture	7.90	7.56
GDP, open economy	5.86	6.46
Exportable	4.59	8.45
Importable	4.02	5.71
Nontradable	7.14	5.91

Source: The dynamic CGE model of Rwanda.

Note: GDP = gross domestic product. In the more-dependent-on-foreign-grants scenario, the foreign grant annual growth rate is 15 percent, while in the less-dependent-on-foreign-grants scenario, the growth rate is 6.5 percent.

By contrast, the way in which public investment is financed has a significant impact on the composition of economic growth. At the sector level, higher growth in foreign inflows benefits industrial growth as a whole but not manufacturing in the open economy. Growth in the closed economy benefits from increased foreign grant inflows, while growth in the open economy falls by 0.6 percentage points per year with more foreign inflows. The benefit of increased foreign inflows to growth in the closed economy goes only to its nonagricultural sector, whose growth rate is 0.34 percentage points higher when the rate of growth in inflows is high. That is to say, with high foreign inflows and for the economy as a whole, growth of the closed economy is more important than the growth of the open economy. For the open economy as a whole, nonmanufacturing growth is more important than manufacturing growth when the level of foreign inflows is high. More foreign inflows are associated with the appreciation of the real exchange rate, which causes the prices in the closed economy to rise relative to those in the open economy, as well as the prices for nontradables (for example, construction is a nontradable) relative to those for tradables (for example, manufacturing) in the open economy.

The simulation results show that the sectors hurt the most by increased foreign inflows are the tradables in the open economy, particularly the exportables, as their annual growth rate falls by almost 3 percentage points when the foreign inflow growth rate is high (Table 4.2). On the other hand, the nontradable sector of the open economy benefits as its growth rate rises by 1.2 percentage points when the foreign inflow growth rate is high. While the overvalued real exchange rate lowers prices for imported intermediates, which benefits the sectors that use such inputs more intensively, lower output prices mitigate benefits to the tradables sector.

To better understand such differential growth effects of foreign inflows on the closed and open economies and between the tradable and nontradable sectors of the open economy, we present the dynamic factors that lead to these growth outcomes in Table 4.3. As Table 4.3 shows, increased foreign grant inflows lead to faster growth in investment. Capital accumulation is thus stimulated in the open economy. A less straightforward outcome is that capital accumulation actually slows down in the closed economy; this is a result of higher relative returns to capital in the open economy. In other words, more private investment takes place in the open economy when foreign capital inflows grow more rapidly, thus slowing down the growth rate of capital accumulation in the closed economy.

Table 4.3 The dynamic factors that lead to the simulation results

Variable	More dependent on foreign grants	Less dependent on foreign grants	
Annual growth rate			
Investment in real terms	10.19	8.62	
Capital accumulation, closed economy	4.54	4.43	
Capital accumulation, open economy	2.39	3.72	
	2013, base-year	**2025, the model results**	
		More dependent on foreign grants	**Less dependent on foreign grants**
TFP growth rate led by public investment	2.55	3.72	3.49
Level of real exchange rate	1.00	1.60	0.81
Effect of real exchange rate on TFP growth rate	1.00	0.74	1.15
TFP growth rate applied to the tradable sector of the open economy	2.55	2.74	4.01

Source: The dynamic CGE model of Rwanda.

Note: TFP = total factor productivity. Real investment includes government investment, while capital accumulation is only for the private sector, that is, the capital employed in the production function.

However, the most important dynamic factor that leads to the different growth outcomes displayed in Table 4.3 seems to be the differences in productivity growth that are an outcome of increased public investment and changes in the real exchange rate.

We display these different productivity effects in the second panel of Table 4.3. As expected, when more foreign inflows lead to more public investment, it results in higher TFP growth rates in all nontradables both in the closed and open economies. However, more foreign inflows also lead to real exchange rate appreciation. Compared with the second scenario in which the real exchange rate depreciates by 19 percent by 2025, the real exchange rate appreciates by 60 percent in the first scenario by 2025.

Thus, in the second scenario, real exchange rate depreciation augments TFP growth rates in the tradables sector, whereas in the first scenario an overvalued real exchange rate lowers TFP growth. The joint effect of the real exchange rate appreciation (negative) and increased public investment (positive) lowers the productivity growth rate in the tradables sector of the open economy in scenario two. This explains the lower GDP growth rates already presented in Table 4.2.

The TFP and labor productivity growth outcomes at the sector level and for the closed and open economies as whole are presented in Table 4.4. Unlike the results presented in Table 4.3 (which are the one-to-one relationships between growth in the productivity parameter [exogenous] and growth in public investment and changes in the real exchange rate [endogenous] at a given elasticity), the TFP and labor productivity growth rates presented in Table 4.4 are calculated from the general equilibrium results of the model. In calculating TFP, we assume a Cobb-Douglas production function for output and calculate TFP as the difference between GDP at constant prices and factor inputs with their share parameters determined by the Cobb-Douglas function (for example, we use the Solow residual as a measure of TFP). In calculating labor productivity, we simply divide GDP at constant prices by the quantity of labor.

Table 4.4 Productivity results from the model (average annual growth rate, 2013–2025)

Variable	More dependent on foreign grants	Less dependent on foreign grants
TFP		
GDP total	2.84	2.95
GDP, open economy	2.40	2.90
GDP, closed economy	3.42	3.23
Agricultural GDP	3.05	2.95
Nonagricultural GDP	3.66	3.37
Labor productivity (GDP per worker)		
GDP total	3.69	3.82
GDP, open economy	2.86	3.30
GDP, closed economy	3.96	3.87
Agricultural GDP	3.08	3.18
Nonagricultural GDP	2.98	3.01

Source: The dynamic CGE model of Rwanda.

Note: Total factor productivity (TFP) is calculated by assuming a Cobb-Douglas production function for gross domestic product (GDP) or sector GDP, which is the model result, and is different from the TFP parameter applied to the model and discussed in the previous table. Also, TFP and labor productivity growth rate rises (or falls) over time in the model, and we report only the annual average in this table.

The TFP growth results in Table 4.4 are more or less consistent with the GDP growth results across sectors and between the closed and open economies presented in Table 4.3. However, the labor productivity results differ from the results for GDP especially for the closed economy. For example, GDP growth in the nonagricultural sector of the closed economy benefits from more foreign inflows. But labor productivity growth in the closed economy's nonagricultural sector is actually slightly lower in the first scenario than in the second scenario. The reason is that more unskilled labor is hired by the nonagricultural sector in the closed economy when there are more foreign grant inflows.

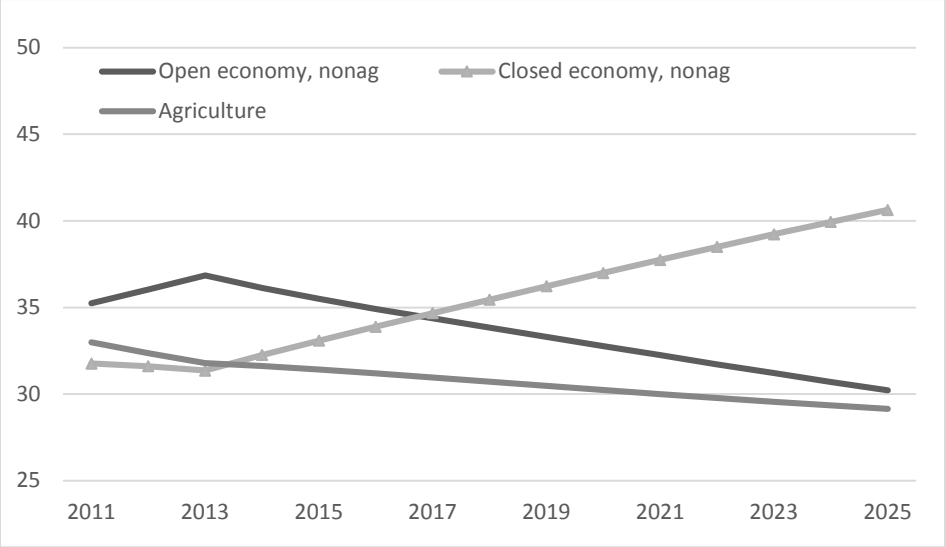
This result is consistent with what we observe in recent years in many developing countries, that is, the closed economy (the in-between activities in the informal sector) has become the dominant sector for job creation. Thus, there seems to exist a trade-off for the in-between sector between its contribution to economywide growth and growth in its overall sectoral labor productivity. When more labor is hired in the closed economy—which is typically very labor intensive—labor productivity falls as a result of increased hiring (at a given level of capital). This indicates that perhaps labor productivity as a measure of the health of the closed economy is misleading. This is because in the closed economy, labor (that is cheaper) substitutes for capital (that is more expensive) in the growth process. Indeed, comparing TFP and labor productivity in Table 4.4, we see that TFP growth is more consistent with the actual growth of nonagricultural GDP in the closed economy, while labor productivity growth in the closed economy moves in the opposite direction to its GDP growth.

The different foreign inflow growth rates also affect structural change differently. We report the results for GDP shares of the closed and open economies in Figures 4.1 and 4.2 for the two alternative scenarios. The initial output shares for these three subcomponents of the economy are roughly the same, with the share for the open economy being the highest at about 35 percent of GDP initially.

When economic growth is more dependent on foreign grant inflows, the share of the nonagricultural sector in the closed economy rises and the share for the open economy falls (Figure 4.1). On the other hand, when growth is less dependent on foreign grant inflows, the GDP share of the open economy rises over time and the GDP share for the closed economy falls; the GDP share of agriculture as a whole falls in both scenarios. Also with less dependency on foreign grant inflows, the magnitude of

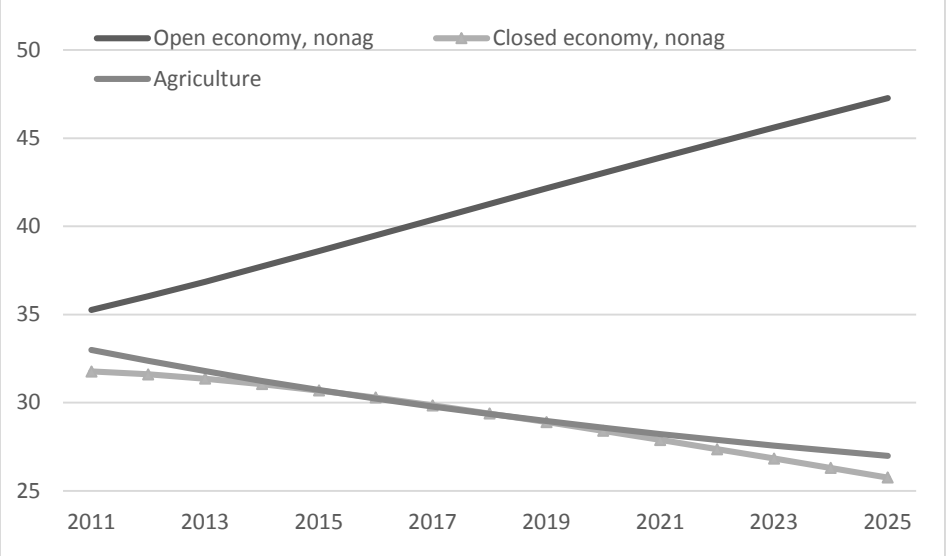
structural change (both in terms of the rising share of GDP for the open economy and the declining share of GDP for the closed economy) is much larger than in the first scenario.

Figure 4.1 Share of three sectors in GDP under more-foreign-grant-dependent scenario (%)



Source: The dynamic CGE model of Rwanda.
Note: Shares are measured in current prices and total gross domestic product (GDP) is 100.

Figure 4.2 Share of three sectors in GDP under less-foreign-grant-dependent scenario (%)

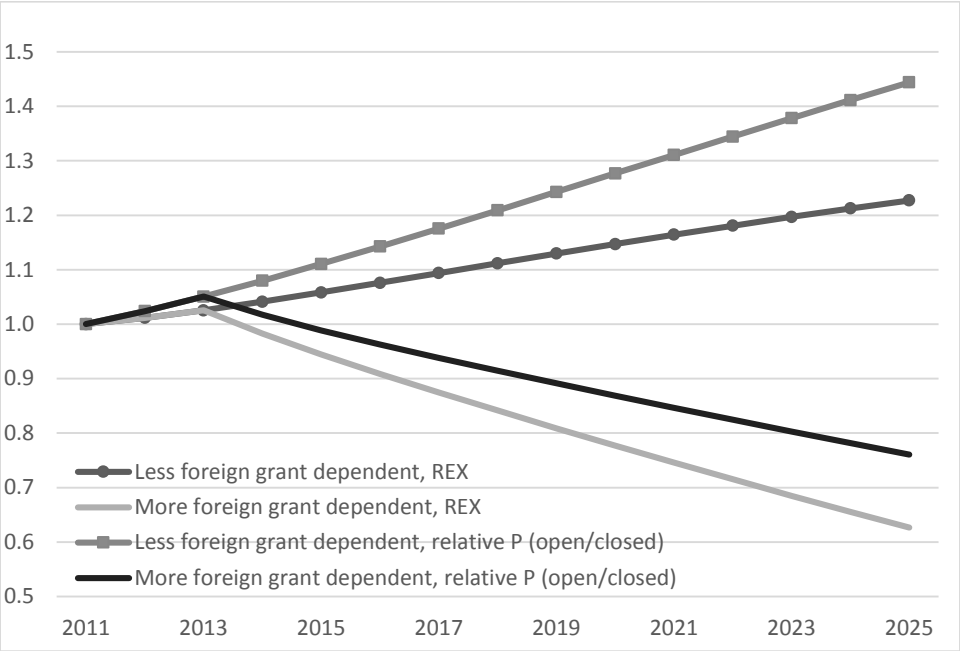


Source: The dynamic CGE model of Rwanda.
Note: Shares are measured in current prices and total gross domestic product (GDP) is 100.

The driving force behind the structural changes in the model simulation is the change in the relative prices in addition to the different growth rates across sectors; both are endogenous general equilibrium outcomes. The movement of relative prices between the open and closed economies is closely associated with the movement of the real exchange rate. As Figure 4.3 shows, when the real exchange rate appreciates under the scenario with more foreign grant inflows, the price index for the closed economy

rises relative to the price index for the open economy. Similarly, when the real exchange rate depreciates under the scenario with less foreign grant inflows, the price index for the open economy rises relative to that for the closed economy.

Figure 4.3 Real exchange rate and relative price index of closed and open economies under the two scenarios (base year value = 1.0)



Source: The dynamic CGE model of Rwanda.

Note: REX = real exchange rate, which is the ratio of world price index and domestic producer price index. Value of REX more than 1.0 implies that domestic price falls relative to the world price, and hence REX depreciates. Relative P (open/closed) = relative price indexes of the open and close economies. P (open/closed) more than 1.0 implies that price index for the open economy increases relative to the price index for the closed economy.

5. CONCLUSION

In this paper we argue that Africa's recent and rapid growth is characterized by a unique set of circumstances. Unlike in Asia, where export-oriented manufacturing led structural transformation, growth in Africa has been dominated by growth in the in-between sector that largely serves domestic markets. This observation has led some to be skeptical about the sustainability of this growth.

Our view is that the features of Africa's recent growth call for a new way of thinking about growth, or a reinterpretation of the Lewis model. To that end, we develop a dual-economy framework that incorporates the coexistence of a closed and an open modern economy. This new framework is designed to allow us to better understand the role of Lewis's (1979) "in-between" economy and domestic markets in Africa's recent growth. In our framework, we emphasize the diversity and heterogeneity of the activities that characterize modern African economies. These activities cannot be neatly divided along sectoral lines such as agriculture versus manufacturing. Instead, we characterize them by whether they serve the domestic market (the closed modern) or the international market (the open modern).

We then apply this new dual-economy framework to the economy of Rwanda to assess Rwanda's future growth prospects based on different levels of foreign inflows. We focus on foreign inflows because much of the argument around sustainability revolves around the concern that if foreign inflows cease, so too will growth. We choose Rwanda because it is characteristic of many of the high-growth countries in Africa whose growth has not been driven by natural resources. However, the results are generalizable to a country where foreign inflows come primarily from natural resources. Using the general equilibrium model we simulate two growth scenarios for the 2012–2025 period: the first is based on continued high growth in foreign capital inflows, and the second is based on a substantial reduction in foreign capital inflow growth.

We find that the differential impact of the levels of foreign inflows on economywide growth is modest; the difference in economywide growth rates between the two scenarios is less than 0.1 percentage point. However, the composition of economic growth is significantly different depending on the assumptions about foreign inflows. Foreign inflows finance infrastructure investment, but they also affect the real exchange rate. Thus, high and sustained foreign inflows stimulate growth primarily in the nonagricultural part of the closed economy. By contrast, foreign inflows have a negative impact on growth in the open economy by making exportables less competitive. Finally, when growth is less dependent on foreign inflows, the contribution of structural change led by the expansion of the open modern economy to overall growth is larger because labor productivity is significantly higher in the open modern economy.

APPENDIX A: MODEL EQUATIONS

The following are the equations of the model. Many equations are adapted from Diao and Thurlow (2012). The model used for this paper is a recursive dynamic CGE model, and we will explicitly discuss which equations are dynamic and which are static below. We also mathematically define the maximization problems for the private agents. When an equation is numbered, it is the one included in the model for solving the equilibrium solution. For those unnumbered equations, they are included for defining the behaviors of agents and helping readers understand the model. We start from consumer behavior and equations.

Consumer Behavior

There are two groups of households, one for the closed economy and one for the open economy, and both follow standard static consumer behavior, that is, each group of households maximizes its aggregate welfare (represented by a utility function) facing a budget constraint. Using a Stone-Geary utility function, the households' consumer problem can be presented mathematically as follows:

$$\underset{i}{\text{Max}}\, U_h = \prod_i (C_{hi} - \gamma_{hi})^{\beta_{hi}};\ \text{h = households (closed, open)}$$

$$\text{subject to} \quad \sum_i (P_i \cdot C_{hi}) = (1 - s_h - ty_h) Y_h,$$

where C is the level of consumption for good i consumed by household h, γ is a minimum subsistence level of consumption for good i, which can be negative for goods highly income elastic in demand, and β are marginal budget shares. Consumption-based utility is maximized subject to the budget constraint equation, in which P is the market price faced by the consumers, s is the saving rate (defined later), ty is an income tax rate, and Y is total income.

Savings of household h is equal to $s_h Y_h$, and following a Solow-style growth model, the total amount of savings for a household adjusts over time in proportion to income levels—that is, the saving rate, s, is fixed. Since savings cannot be used to smooth consumption over time—as is the case in Ramsey-style intertemporal dynamic models,[5] there does not exist intertemporal dynamic optimization, a typical caveat for a recursive dynamic model.

Maximizing the consumer utility function generates the following set of demand functions, which are the equations applied in the CGE model for the consumer problem:

$$C_{hi} = \beta_{hi}[(1 - s_h - ty_h) Y_h - \sum_{i'} (P_{i'} \cdot \gamma_{hi'})] P_i^{-1}, \quad where\ i' \approx i. \tag{1}$$

Equation 1 is known as a special case of nonhomothetic demand functions, that is, linear expenditure system (LES) of demand. It permits changes in consumption patterns over time, as there exists a subsistence level of consumption γ, which can also vary across products. While all goods are assumed to be "normal" (that is, have a positive income elasticity), the LES can distinguish between "necessity" goods (elasticity less than one) and "luxury" goods (elasticity greater than one). With existence of nontradable goods in the model (which will be defined later), a nonhomothetic demand system results in structural change in the model's economy when household income grows over time.

[5] See Diao, Yeldan, and Roe (1998) for a discussion of Ramsey-style intertemporal utility functions and their role in determining consumers' consumption and saving behavior.

Producer Behavior

Producers are defined at the sector level. A typical producer maximizes profits given a set of input and output prices. Consistent with neoclassical general equilibrium theory, we assume constant returns to scale technology. Accordingly, a constant elasticity of substitution (CES) function is chosen as the production function for each sector:

$$X_i = \Lambda_i \left(\sum_f \alpha_{if} \cdot V_{if}^{-\rho_i} \right)^{-1/\rho_i}, \tag{2}$$

where X is the output quantity of sector i, Λ is a shift parameter reflecting total factor productivity (TFP), V is the quantity demanded of each factor f (that is, land, labor, and capital), and α is a share parameter of factor f employed in the production of good i. As with any production function, producers combine the factors of production to produce a certain level of output. The elasticity of substitution between factors σ is a transformation of ρ (that is, $\sigma = 1/(1+\rho)$).

Profits π in sector i are defined as the difference between revenues and total factor payments:

$$\pi_i = PV_i \cdot X_i - \sum_f \left(W_f \cdot V_{if} \right),$$

where PV is the value-added component of the producer price, and W is factor prices (for example, labor wages, returns to land, or capital rents). With constant returns to scale technology, π_i is zero at the maximization. Maximizing sectoral profits subject to Equation 2 and rearranging the resulting first-order condition provides the system of factor demand equations used in the model:

$$V_{if} = \Lambda_i^{-\frac{\rho_i}{1+\rho_i}} \cdot X_i \left(\alpha_{if} \cdot \frac{PV_i}{W_f} \right)^{1/(1+\rho_i)}. \tag{3}$$

Intermediate inputs are also used in the production process. Leontief technology is assumed for the relationship between intermediate input use and gross output. Demand for intermediates is determined by the fixed input-output coefficients $io_{i'i}$ between good i' used in the production of output i. The complete producer price is then defined as

$$PP_i = PV_i + \sum_{i'} P_{i'} io_{i'i}. \tag{4}$$

We define $i \in I$ as a set for all sectors, while the closed and open economies can be represented by two subsets of I, that is, $i_c \in I_c$ and $i_o \in I_o$. To simplify the model, we consider a similar good, for example, a processed food product, produced in the closed and open economies as two different goods, such that $I_c + I_o = I$ and $I_c \cap I_o = 0$. We further assume that, with a few exceptions, the closed households consume goods belonging to I_c and the open households consume goods of I_o, while producers in both economies use all goods (some can be zero) of I. The lists of sectors in the closed and open economies can be found in Appendix B.

Behavioral Functions Governing International Trade

Following Armington (1969) who developed a structural model in which a domestically produced and consumed good is an imperfect substitute for similar imported goods, we assume imperfect substitution between domestic goods produced by the open economy and similar goods supplied to and from foreign markets, while for the closed economy all goods are nontradable. CES functions are used to define the relationship between domestically produced and imported goods in the open economy:

$$Q_{i_o} = \Omega_{i_o} \left[\mu_{i_o} \cdot D_{i_o}^{-\theta_{i_o}} + \left(1 + \mu_{i_o}\right) M_{i_o}^{-\theta_{i_o}} \right]^{-1/\theta_{i_o}}, \tag{5}$$

$$(15tc_{i_o})P_{i_o} \cdot Q_{i_o} = PD_{i_o} \cdot D_{i_o} + PM_{i_o} \cdot M_{i_o}, \text{and} \quad (6)$$

$$PM_{i_o} = (1 + tm_{i_o})pwm_{i_o}.$$

While in the closed economy, we have

$$Q_{i_c} = D_{i_c}, \text{and} \quad (5')$$

$$P_{i_c} = PD_{i_c}. \quad (6')$$

In Equation 6, *tc* is an indirect sales tax, *Q* is the composite good consumed domestically, *D* and *M* are domestically supplied and imported quantities, and *PD* is the price of domestic good *D*. The import price *PM* in our model is determined exogenously by world imports prices *pwm* and import tariff rates *tm* under a small country assumption.

Similarly, imperfect substitution is also assumed for exports in the open economy. A constant elasticity of transformation (CET) function determines the relationship between the quantity of goods produced in the open economy for domestic and foreign export markets:

$$X_{i_o} = \Gamma_{i_o}\left[\tau_{i_o} \cdot D_{i_o}^{\varphi_{i_o}} + (1 + \tau_{i_o})E_{i_o}^{\varphi_{i_o}}\right]^{1/\varphi_{i_o}}, \quad (7)$$

$$PP_{i_o}.X_{i_o} = PD_{i_o} \cdot D_{i_o} + PE_{i_o} \cdot E_{i_o}, \text{and} \quad (8)$$

$$PE_{i_o} = (1 - te_{i_o})pwe_{i_o},$$

where *E* is the quantity of good i_o exported, *te* is the export tax rate, and *pwe* is the exogenous world export price. Analogous to import substitution, the CET export function allows producers in the open economy to switch between supplying domestic and foreign markets depending on relative price changes.

Mathematically, maximizing $(1 - tc_{i_o})P_{i_o}Q_{i_o} - PD_{i_o}D_{i_o} - PM_{i_o}M_{i_o}$ subject to Equation 5 and rearranging the resulting first-order condition gives the following equation defining the ratio of *D* and *M*:

$$\frac{D_{i_o}}{M_{i_o}} = \left(\frac{\mu_{i_o}}{1-\mu_{i_o}} \cdot \frac{PM_{i_o}}{PD_{i_o}}\right)^{1/(1+\theta_{i_o})}. \quad (9)$$

Similarly, minimizing $PP_{i_o}X_{i_o} - PD_{i_o}D_{i_o} - PE_{i_o}E_{i_o}$ subject to Equation 7 gives the ratio of D and E:

$$\frac{D_{i_o}}{E_{i_o}} = \left(\frac{\tau_{i_o}}{1-\tau_{i_o}} \cdot \frac{PD_{i_o}}{PE_{i_o}}\right)^{1/(\varphi_{i_o}-1)}. \quad (10)$$

The above two equations specify the substitution responses described earlier (that is, between relative prices and quantities). The ease at which producers or consumers switch between domestically produced and foreign goods is determined by elasticities of substitution θ and φ. The larger elasticities permit greater responsiveness to relative price changes. These elasticities can be estimated based on historical quantity-price relationships using econometrics or back-casting techniques (see, for example, Arndt, Robinson, and Tarp 2002).

Equilibrium Conditions

Following a tradition on general equilibrium theory, a full employment assumption is applied to all factors such that their returns are determined endogenously by their market equilibrium conditions:

$$\sum_i V_{if} = vs_f, \tag{11}$$

where *vs* is the total factor supply and *V* is factor demand in each sector (determined in Equation 3).

There are six types of factors in the model: land, three types of labor, and two types of capital. Land is employed in agriculture only. Labor is grouped into three types: agriculture, unskilled, and skilled. Agricultural labor is employed in the closed economy's agricultural sectors, unskilled labor is employed in the open economy's agricultural and closed economy's nonagricultural sectors, while skilled labor is employed in the open economy's nonagricultural sectors. The model is set up in a way that only one type of labor is used in any sector, and hence, the skill definition is less relevant—that is, we deliberately isolate two types of labor according to the sectors in the closed or open economies instead of skill. There is one exception: in the open economy's nontradable industrial sector (construction) both unskilled and skilled labor is employed. Two types of capital are corresponding to the closed and open economies, and we can call them closed and open capital. All factors are mobile in the model among the sectors they are employed in. Supply of each factor is fixed in any given year and grows at an exogenous rate for labor and land. Growth in capital is through a link to investment that will be discussed later.

Factors are owned by households. We assume that land, agricultural and unskilled labor, and closed capital are owned by the closed households, while skilled labor and open capital are owned by the open households. Both groups of households also receive transfers from the government, such that household income *Y* is determined by

$$Y_{h_o} = \sum_{f_o} w_{f_o} \cdot vs_{f_o} + trnsfr_o;\ f_o = (skilled\ labor\ of\ open\ capital), \text{ and} \tag{12a}$$

$$Y_{h_c} = \sum_{f_c} w_{f_c} \cdot vs_{f_c} + trnsfr_c;\ f_c = (land, ag\ labor, unskilled\ labor), \tag{12b}$$

where *trnsfr* is the amount of income received by the households from the government, and is an exogenous variable with a fixed growth rate.

Domestic prices, *PD*, are determined by product market equilibrium conditions as follows:

$$Q_i = \sum_h C_{ih} + N_i + G_i + \sum_{i'} (io_{i'i} \cdot X_i), \tag{13}$$

where *N* is investment demand and *G* is government recurrent consumption spending (both defined later).

The relationship between savings and investment demand *N*, and taxes and government spending *G*, will be specified below. However, in the absence of taxes or savings (that is, when *ty*, *tf*, *s*, *N*, and *G* are all zero), the above 13 equations simultaneously solve for the values of the 13 endogenous variables (that is, *Y*, *C*, *X*, *V*, *Q*, *D*, *M*, *E*, *P*, *PV*, *PP*, *PD*, and *W*). The general equilibrium solution defined by the equations only holds if there are no foreign transfers—implicitly balanced trade. This assumption is often made in simple theoretical general equilibrium models, but it is rarely used in CGE models, which need to be calibrated to observed data for a country. Moreover, for the purpose of this paper, the unbalanced trade, and hence the magnitude of foreign inflows, is an instrument for designing the model scenarios. We will introduce foreign transfers and current account imbalances after we first define government *G* and investment demand *N*.

Government and Investment Demand

The government in our CGE model appears as a separate institution with incomes, expenditures, and savings/investment. However, the government's decisions are not solved as an optimization problem. Total domestic revenues *R* of the government are the summation of all individual tax revenues:

$$R = \sum_i (tc_i \cdot P_i \cdot Q_i + tm_i \cdot pwm_i \cdot M_i + te_i \cdot pwe_i \cdot E_i) + \sum_h (ty_h \cdot Y_h), \quad (14)$$

where all tax rates are exogenous and will not be used as instruments in this paper for simulating any policy change. The government also receives income from abroad, mainly via foreign grants (foreign aid). This additional income source will be discussed below when we introduce our macroeconomic closure.

The government uses its revenues to purchase goods and services (that is, recurrent consumption spending), to pay the transfers to the households, and to save (that is, to finance public capital investment), as shown below:

$$R = \sum_i (P_i \cdot G_i) + \sum_h tnsfr_h + FB, \quad (15)$$

where *G* is consumption spending from Equation 13 and *FB* is the recurrent fiscal surplus (or deficit if negative). Since we do not have behavioral functions that optimize revenues and expenditures, our model does not endogenously balance government accounts. Rather we assume that *G* is determined exogenously; the fiscal balance *FB* is therefore merely a residual balancing item.

There is also no behavioral function determining the level of investment demand for goods and services (that is, *N* from Equation 13). The total value of all investment spending must equal the total amount of investible funds *I* in the economy. We therefore assume that the value of *N* for each good *i* is in fixed proportion to the total value of investment, as seen below:

$$\varepsilon_i \cdot I = P_i \cdot N_i, \quad (16)$$

where ε is the value share for each investment good *i*, and *P* is the market price determined by the equilibrium condition in Equation 13. To determine the value of *I* we must define our macroeconomic closures.

Current Account and Macroeconomic Closures

Macroeconomic balance in a CGE model is determined by a series of *closure rules*. The most important of these is for the current account balance. When a CGE model is calibrated to observed data for a country where current accounts are invariably imbalanced (often in deficit for an African country like Rwanda), the model will not be able to achieve equilibrium unless external financial flows are included explicitly. Such foreign inflows are either in the form of foreign aid received by the government or foreign direct investment. We start from the well-known identity linking a country's current account balance *CA* to national savings *S* and investment *I*:

$$CA = TE - TM - NFI \equiv S - I = \Delta NFA, \quad (17)$$

$$\text{where} \quad TE = \sum_i (pwe_i \cdot E_i) \quad \text{and} \quad TM = \sum_i (pwm_i \cdot M_i).$$

The left-hand-side of the identity states that a country's current account balance is equal to its trade balance (*TE – TM*) less net foreign incomes *NFI*. A country is therefore running a current account deficit whenever the sum of its trade balance and *NFI* is negative, in which case national investment exceeds national savings and there is an accumulation of net foreign debt, that is, $\Delta NFA < 0$ and $|\Delta NFA|$ increases over time. Total savings in the economy is the sum of all household savings and the government's recurrent fiscal balance, as shown below:

$$S = \sum_h (s_h \cdot Y_h) + FB. \quad (18)$$

The choice of current account closure influences how we select our second closure rule, which is the identity on the right-hand-side of Equation 17. By fixing *CA* in each time period, we are also fixing the value of *ΔNFA*, which means that either total savings *S* or total investment *I* (but not both) should be determined exogenously. We call this choice the "savings-investment" closure, which is a term borrowed from macroeconomics. If the CGE model is "savings driven" then *I* is automatically determined by the level of total available savings (that is, $I = S - \Delta NFA$). Consistent with Equation 1 in which *s* is a fixed parameter, our model specification is savings driven. Finally, our treatment of the government balance in Equation 15 is in fact the third closure rule in the model. We choose to make recurrent consumption spending *G* exogenous and allow the fiscal balance *FB* to adjust to changes in revenues *R*.

Through our introduction of the government, investment demand, and macroeconomic closures, we have included five new equations into the model (Equations 14–18) and five new endogenous variables (*R*, *FB*, *N*, *I*, and *S*).[6] Together, the 18 equations and variables describe a static single-country model. Our current account closure fixes the national trade balance. The government closure implies that changes in revenues alter the fiscal balance (and hence public investment). In our savings-driven closure, total investment adjusts to match total savings. To determine the lasting consequences of changing investment levels, we have to introduce dynamics into the model.

Recursive Dynamics

As mention earlier, consumers' demands are derived from a one-period utility function, and saving rates are not endogenously determined by an intertemporal utility function. Investment and capital accumulation rates are therefore not intertemporally determined either. Rather, the dynamics in our CGE model is defined as a recursive process. This means that for most equations we can completely separate the model into "within-period" and "between-period" components. The equations presented above fully specify the within-period component, while there are two types of between-period equations, those with exogenous variables that are updated with given exogenous growth rates, and those in which the value of a stock variable (for example, capital) or a coefficient (for example, TFP) is linked to the model's endogenous variables recursively. We describe these two kinds of updating procedures in turn and start with the first type.

The exogenous trend that needs to be considered in the model is growth in factor supplies including land and three types of labor, which are represented by vs_f in Equation 11. The dynamic (or between-period) equation updates the exogenous supplies of factors as shown below:

$$VS_{ft+1} = VS_{ft}\left(1 + gv_{ft}\right) \quad \text{where } f \neq k, \quad (19)$$

where *t* is a time subscript in the simulation period (for example, year), *k* is a subset of *f* containing the capital factor, gv_f is the annual growth rate in supply for factor *f*. While population growth is a driving factor to explain labor growth, taking into consideration rural-to-urban migration, growth rate differs across the three types of labor supply in the model.

There are many different ways to capture labor reallocation from agriculture to nonagriculture activities and from low-productivity to high-productivity sectors in general equilibrium models. In the literature for static general equilibrium models, labor market structure or wage determinant rules are often used as driving forces in determining labor reallocation. In this paper we follow neoclassic general equilibrium assumptions for the labor market as defined in Equation 11. That is, we consider only the rural-to-urban or agriculture-to-nonagriculture labor mobility among the new comers in the labor market. In this way, we can use different growth rates between agricultural labor supply and nonagricultural labor supply to capture labor mobility, which significantly reduces the complexity of the model's equilibrium conditions and hence allows the model results to be less dependent on the assumptions about labor market

[6] Note that our third closure rule made *G* exogenous in Equation 15.

structure and wage determinant rules, an issue that is not the focus of the paper. We have less concern for this assumptions about labor market structure due to a common phenomenon for low-income developing countries in which the absolute level of agricultural labor supply continues to grow even when the share of agricultural labor in total labor supply falls. This situation is expected to last for a quite long period during economic transformation in developing countries, particularly for African countries that often have a high population growth rate. Specifically in the model, we assume that agricultural labor supply grows more slowly than the population growth rate—leading to the declined share of agricultural labor in total labor supply over time. Between the closed and open economies, we assume that unskilled labor supply grows more rapidly than the supply of skilled labor, which is also a commonly observed phenomenon in low-income developing countries. The weighted growth rate of the three types of labor, however, equals the population growth rate.

Given that both government's consumption spending and Δ*NFA* are exogenous, they need to be updated every period based on exogenous trends too. We define -Δ*NFA* as *FSAV*, which becomes positive when Δ*NFA* is negative, and have the following two equations to update these two exogenous macro closure variables:

$$G_{it+1} = G_{it}(1 + gg_{it}), \text{ and} \tag{21}$$

$$FSAV_{t+1} = FSAV_t(1 + gfs_t), \tag{22}$$

where *gg* is the growth rate of government recurrent spending and *gfs* the rate of change in foreign inflows. The exogenous growth rates in Equations 19 through 21 are fixed and are the same in all scenarios, while *gfs* in Equation 22 is an instrument to shock the model under alternative scenarios—that is, it differs in different scenarios. We will come back to it later.

Shift parameter, Λ_i, in Equation 2 represents the level of TFP in sector *i* in a given time period. This parameter needs to be updated over time:

$$\Lambda_{it+1} = \Lambda_{it}(1 + gp_{it}), \tag{23}$$

where *gp* is the growth rate of TFP.

For the purpose of this paper, we define *gp* as a function of public investment and real exchange rate to explicitly model the endogenous relationship between productivity growth and these two variables that are often understood as key drivers of productivity growth in developing countries. We first need to define public investment for this purpose. Let QI_p and QI_g be quantities of private and public capital, which are formed from private and public investment, respectively. Then, total capital in the quantity, that is, $QI = QI_p + QI_g$, can be defined as I/PK, where *I* is the value of total investment as defined in Equation 17, and $PK = \sum_i \varepsilon_i P_i$, a weighted price index with weights as the value shares of individual investment goods *i* in the total investment basket defined in Equation 16. To simplify the problem, we assume that both public and private investments have similar investment baskets, such that QI_g can be defined proportionally to total investment *I*, financed through the government account (that is, foreign grants that finance such investment have to go through the government account as part of *FB*), that is, $QI_g = \frac{FB}{PK}$.

The real exchange rate is defined as the ratio of an international price index over an index for domestic producer prices. As international prices are constant in the model, the real exchange rate, *REX*, can be simply defined as an inverse of domestic price index and normalized to 1 in the initial period of the model, that is, $REX = \frac{1}{\sum_i \varphi_i PD_i}$, and φ_i is the value share of good X_i in gross value of all good *X*. We assume that public investment has a positive and uniform effect on TFP across sectors, while the real exchange rate affects tradable sectors in the open economy only, and such effect is modeled as augmenting the effect of public investment to productivity. Specifically,

$$gp_{i_c t+1} = \theta \cdot QI_g{}^{\delta_g}, \text{ and} \tag{24a}$$

$$gp_{i_o t+1} = \theta \cdot QI_{gt}{}^{\delta_g} REX_t{}^{\delta_{REX}}, \tag{24b}$$

where δ_g and δ_{REX} are elasticity of public investment and the real exchange rate, respectively, in the TFP growth function, and θ is chosen such that gp_i equals 0.025 in the initial period of the model—that is, if public investment keeps at its current level for the future, TFP will grow at 2.5 percent economywide. This growth rate is consistent with the result of a simple growth accounting exercise using the actual data of Rwanda.

The dynamics of the model also come from capital accumulation. We assume that only the private investment becomes newly formed capital (net capital depreciation)—that is, the amount of new capital is determined by dividing private investment *I – FB* by the capital goods price index, *PK*. In each period, capital is sector specific, while newly formed capital will be allocated to different sectors endogenously according to the relative returns of sector capital in the previous period defined later. The following equation describes the aggregate capital accumulation process:

$$vs_{kt+1} = (11d)vs_{kt} + \frac{I_t - FB_t}{PK_t}, \tag{25}$$

where *d* is the depreciation rate, and *PK* is, again, the index of investment goods' prices. As capital is not mobile in a given period, the returns on capital in each sector are not equal. We therefore attach a sector-specific "distortion" term *Z* in front of the economywide factor return variable *W* in Equations 3, 12, and 14. Equation 3 is now replaced by

$$V_{if} = \Lambda_i^{-\frac{\rho_i}{1+\rho_i}} \cdot X_i \left(\alpha_{if} \cdot \frac{PV_i}{Z_{if} \cdot W_f} \right)^{1/(1+\rho_i)}, \tag{3'}$$

where *Z* is an adjustment factor ($0 < Z < \infty$) and is initially set equal to one. Similarly, we replace Equation 25 with a capital stock updating equation defined at the sector level (that is, in terms of *V* instead of *vs*):[7]

$$V_{ikt+1} = (11d)V_{ikt} + SK_{ikt} \cdot \frac{I_t - FB_t}{PK_t}. \tag{25'}$$

The term *SK* in Equation 25' is the new capital allocation parameter ($0 < SK < 1$) and specifies how much investment is directed toward each sector. SK_i therefore sums to one. We follow the approach of Dervis, de Melo, and Robinson (1982) by defining *SK* as follows:

$$SK_{ikt} = SP_{ikt} + \omega \cdot SP_{ikt} \left(\frac{SR_{ikt} - AR_t}{AR_t} \right), \tag{26}$$

where *SP* is the current sectoral share in aggregate capital profits, *SR* is the sectoral profit rate (that is, $Z_{if} W_f$), and *AR* is the economywide average capital profit rate. In this simple specification, new capital is allocated in proportion to each sector's share in aggregate capital income, adjusted by the sector's profit rate relative to the average profit rate. Sectors with higher-than-average profit rates receive a larger share of investible funds than their share in aggregate profits. The term ω is an investment mobility parameter. When it is zero it is assumed that there is no intersectoral mobility in investment funds. When it is greater than zero, then funds are allocated based on profit-rate differentials and favor the sectors with above-average capital returns. Thus the investment allocation procedure is known as a "putty-clay" specification, since new capital is mobile, but once invested it becomes sector specific.

[7] For mobile factors, *Z* and *vs* remain constant and *W* and *V* adjust to clear factor markets. For sector-specific factors, such as capital, *W* and *V* are fixed, and *Z* and *vs* are the adjustment variables.

Calibrating the Model to Rwanda's Data

CGE models need to calibrate to detailed empirical data such that to assign values to the model's parameters and variables at the benchmark consistent with observed country data. Some of the assumptions that we made when specifying the CGE model were done to ease its calibration, since in many cases the data needed for more complex functional forms are unavailable in developing countries. For example, the LES function that we use to determine consumer demand assumes that income elasticities remain constant, which allows us to use micro (household) data to estimate such elasticity consistently with the expenditure shares in the survey and hence in the model. Calibrating the behavior of more complicated functional forms often just involves making more assumptions where data are unavailable. In this section we describe the data sources and estimation procedures used to calibrate our CGE model for Rwanda.

The Rwandan Social Accounting Matrix

The values of most variables and parameters in the CGE model are drawn from a social accounting matrix (SAM).[8] Constructing a SAM is therefore a fundamental part of developing a CGE model. A SAM is an economywide representation of a country's economic structure. It captures all income and expenditure flows between producers, consumers, the government, and the rest of the world during a particular year, and such information is used to calibrate the core model described above.

The original SAM for Rwanda was developed under an IFPRI research project in 2008 (Diao et al. 2010), which was based on a 2006 SAM constructed by Arnault Emini (2007) under a joint project between MINECOFIN in collaboration with MINAGRI and the World Bank. The 2006 SAM was recently updated to 2011 by Diao and Pradesa (Diao, Bahiigwa, and Pradesha 2014). For the purpose of this paper, this SAM was regrouped into the sectors displayed in Appendix B and two household groups.

The 2011 SAM has 54 sectors in total (the list of these 54 sectors can be found in Diao, Bahiigwa, and Pradesha 2014). We regrouped them into 19 sectors (see Table B.1 in Appendix B), and also made necessary adjustments such that a nontradable sector in the closed economy has a counterpart (tradable one) in the open economy—for example, cereals–nontradable, an agricultural sector in the closed economy, versus cereals–importable, an import-substitutable agricultural sector in the open economy. The trade data at the sector level are used to define the imports and exports in the open economy. We did not consider the two-way trade for any particular sector—that is, the net trade (either net exports or net imports) at the sector level is used for structuring the trade flows, such that the linkages between imports/exports and domestic production in the open economy can be explicitly traced when the model is used for a scenario analysis. We did not split the nontradable industrial sector (construction) and public service sector (also nontradable) into closed and open economies and both are treated as parts of the open economy in the model.

The 2011 SAM has four types of labor, two types capital, five types of agricultural cropland, and five types of livestock capital stocks. For the purpose of this paper, we reclassified these factors according to the new sector structure. For any labor employed in the nontradable agricultural sectors in the closed economy, we define it as agricultural labor. For any labor employed in the tradable sectors in the open economy, we define it as skilled labor. The rest of labor is called unskilled labor, which is employed in tradable agricultural sectors and nontradable nonagricultural sectors in the open economy. The only exception is the labor employed in the nontradable industrial sector in the open economy, and such labor is split between skilled and unskilled. We treat livestock sectors' initial stocks similarly to land to simplify the endowment structure of the closed economy.

As we mentioned above, we assume that the closed household group consumes goods produced in the closed economy and the open household group consumes goods produced in the open economy (or imports). There are three exceptions, livestock products, manufacturing consumer goods, and public services, which are consumed by both household groups. Livestock is a closed economy's sector, while

[8] For detailed discussions on SAMs see, for example, Pyatt and Round (1985) and Reinert and Roland-Holst (1997).

the two nonagricultural sectors are parts of the open economy. Moreover, as intermediate inputs, any sector in both closed and open economies can consume the goods produced outside its economy, while government's consumption and investment are all part of the open economy.

Behavioral Elasticities and Other External Data

Behavioral elasticities are needed for the consumption, production, and trade functions. The LES demand function requires information on income elasticities and the Frisch parameter (see Frisch 1959). We econometrically estimate income elasticities using the data of the *Household Living Conditions Survey 2010/11* (EICV 3), and the same survey data are used to update the SAM to 2011. The estimation follows the approach described in King and Byerlee (1978). Marginal budget shares (that is, β in Equation 1) are derived by combining the estimated income elasticities with the average budget shares drawn directly from the SAM.

Trade elasticities determine how responsive producers and consumers are to changes in relative prices in the open economy. Considering that trade is part of the open economy, which distinguishes it from the closed economy, it is reasonable to assume a much higher elasticity than that used in other CGE models. That is, the value of θ and φ in Equations 5 and 7 is equal to 8 for all tradable sectors in the open economy.

The elasticities governing factor substitution in the production functions (that is, ρ in Equation 2) rarely exist for developing countries. In the absence of reliable country-specific estimates, we assume inelastic factor substitution for most activities (that is, $\sigma < 1$: σ is a transformation of ρ). Specifically, considering that land is used only in agricultural sectors and agricultural labor differs from other labor in the model, we assigned the lowest elasticity (0.28) for the agricultural sectors in both closed and open economies. Besides mining, which is constrained by the natural resource condition, we assign relatively higher elasticity for tradable sectors in the open economy (0.47), and the highest elasticity for the nontradable nonagricultural sectors in both economies (0.73).

Finally, the SAM provides information on values but not quantities. We therefore use external data sources to calibrate the model's production output X and factor quantities vs. For example, crops' land use and gross output are calibrated to match agricultural data on harvested area (in hectares) and production quantities (in metric tons). We paid particular attention to the calibration of wage rates for different types of labor. Rwanda has not yet conducted labor or manufacturing surveys in the recent years, and we have to turn to EICV3's module 6—economic activity in the last 12 months and the last 7 days—for a better understanding of employment structure at the present in the Rwandan economy. Section 6 of EICV3 includes a set of questions regarding the occupations of all members of households sampled. Both agricultural and nonagricultural activities are covered, and unpaid jobs, paid jobs, and self-employed are distinguished. Moreover, for the paid nonagricultural activities, they are further categorized according to 29 industrial categories.

29,082 individuals reported working at least one hour in the last 7 days, and an additional 3,442 individuals reported working at least one hour in the last 12 months. This group of individuals forms the dataset for us to analyze the occupational structure in the current Rwandan economy. There are 23,328 individuals who report not working either in the last 7 days or in the last 12 months. However, most of them are either students (77.6 percent) or too young to work (13.4 percent). That is to say, if we consider adults aged at least 15 years or older, almost everybody worked in Rwanda, which is a common phenomenon in most low-income developing countries—that is, underemployment instead of unemployment characterizes the occupational structure of labor markets in such countries. The survey also reports the payment situation of employment. About one-third of employees are reported as unpaid workers, another 15 percent as self-employed, and the rest, about 55 percent, are paid workers. Among the paid workers, about one-third reported working less than 20 hours in the last seven days, a phenomenon of working as casual workers. For the paid workers, the survey further reports their sector structure. In general, paid jobs in agriculture are more part-time, and more than 40 percent of total paid workers who worked less than 20 hours per week were working in agriculture, while for the workers

working more than 20 hours a week, almost 80 percent were in the nonagricultural sectors. Using such information, we make a good guess for the size of the labor force for agricultural, skilled, and unskilled labor. At the aggregate level for the three types of labor, we do not distinguish the workers as paid and unpaid and part-time or full-time. Instead, we assign an extremely low average wage rate for the agricultural labor, of which many are unpaid, self-employed, or part-time. The wage rates for skilled labor and unskilled labor are chosen such that the number of such laborers (according to the sectors they are employed in) makes more sense for the country based on a scientific guess. Value-added from labor at the sector level has to be consistent with its value in the SAM, which is the other constraint we have to consider when we guess the wage rate. As a result of all these considerations, agricultural labor accounts for 75 percent of the total labor force, consistent with the macro data the country uses, while unskilled labor accounts for about 18 percent and skilled labor 7 percent. The agricultural average wage rate is about 15 percent of the wage rate for unskilled labor, and the wage rate of unskilled labor is about 50 percent of skilled labor's wage (see Table B.2 in Appendix B).

Benchmark Dynamics Calibration

While the model is calibrated to the base year's unique equilibrium represented by the data in the SAM, this dataset does not imply a unique year 2's equilibrium, which depends on a calibration strategy to inform capital accumulation in year 2 using year 1's investment data that are included in the SAM. We adopt a calibration strategy such that the initial growth rate in capital accumulation is consistent with the growth rate of skilled labor, given that skilled labor is employed in the tradable sectors of the open economy and most such sectors are also capital intensive (that is, most capital is employed in such sectors). After year 2, growth rate in capital accumulation will be endogenously determined by growth in private investment, indirectly affected by changes in the growth rate of TFP, which is an outcome of changes in growth rate of public investment and the real exchange rate. That is, the annual growth in capital stocks becomes endogenous after year 2. The benchmark calibration for TFP growth was discussed above when we introduced the equation for TFP growth rate (Equation 24) in which public investment and real exchange rate are endogenous variables. Elasticity of TFP with respect to public investment and the real exchange rate can be found in Table B.3 in Appendix B.

Additional model results can be found in Appendix C.

APPENDIX B: SECTORS, INITIAL VALUE OF SELECTED VARIABLES, AND PARAMETERS

Table B.1 Sectors and economic structure of the Rwandan SAM in 2011

	Sector share		
Sector	**in GDP**	**in total labor**	**in total capital**
The closed economy	***46.57***	***86.31***	***10.94***
Cereals, nontradable	4.80	14.39	
Other crops, nontradable	18.10	52.78	
Livestock	2.03	4.86	
Processed food, nontradable	2.10	1.12	2.93
Other services, nontradable	19.54	13.16	8.01
The open economy	***53.43***	***13.69***	***89.06***
Cereals, import substitutable	1.31	0.32	
Other crops, exportable	5.82	2.17	
Traditional export crops	0.91	0.36	
Mining	1.37	0.09	4.98
Processed food, import substitutable	0.39	0.02	1.42
Processed food, exportable	1.17	0.15	3.18
Consumer manufacturing goods, import substitutable	1.92	0.22	5.94
Intermediate manufacturing goods, import substitutable	0.34	0.02	1.20
Investment manufacturing goods, import substitutable	1.25	0.11	4.17
Nontradable industry (construction)	10.13	3.44	26.75
Modern services, nontradable	9.88	3.16	4.90
Exportable services	4.36	0.66	12.45
Importable services	4.69	0.59	13.32
Public services	9.87	2.39	10.75

Source: The 2011 19-sector Rwandan social accounting matrix (gross domestic product [GDP]) and calibration result (factors).

Table B.2 Wage rates and factor returns in year 1 in the model (100,000 FRW)

Factor	Return rate
Agricultural labor	0.23
Skilled labor	3.24
Unskilled labor	1.62
Open capital	0.50
Closed capital	0.50
Land	0.31

Source: Calibration results of the 2011 19-sector Rwandan social accounting matrix.

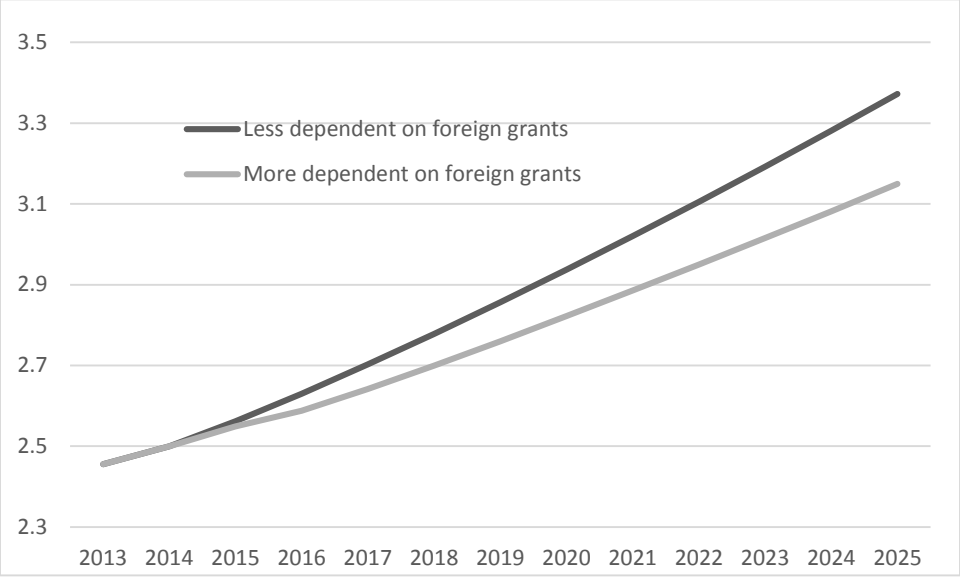
Table B.3 Elasticity in total factor productivity growth function in the model

Public investment	0.28
Real exchange rate	0.72

Source: Authors own estimation.

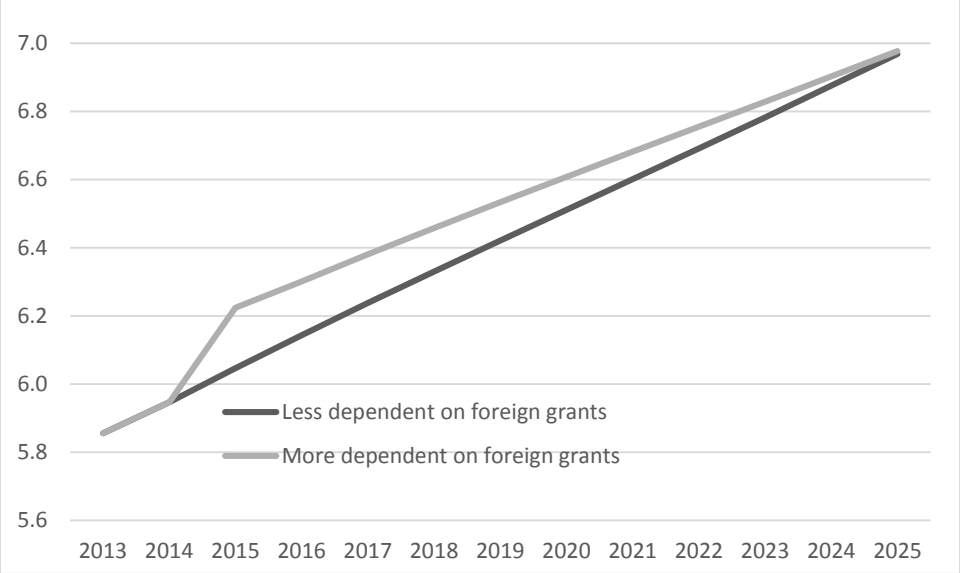
APPENDIX C: SELECTED MODEL RESULTS

Figure C.1 Total factor productivity growth rate (%)



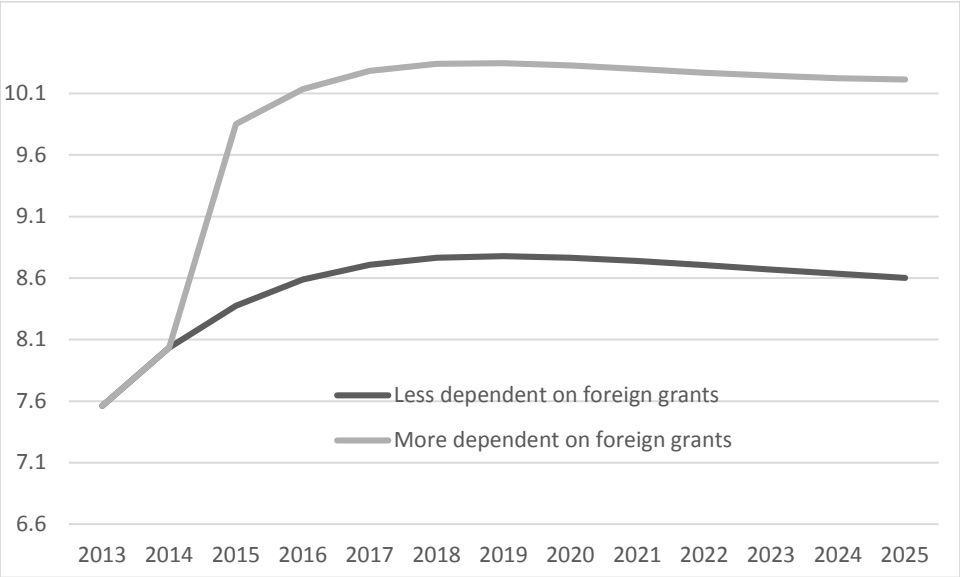
Source: The dynamic CGE model of Rwanda.

Figure C.2 National gross domestic product growth rate (%)



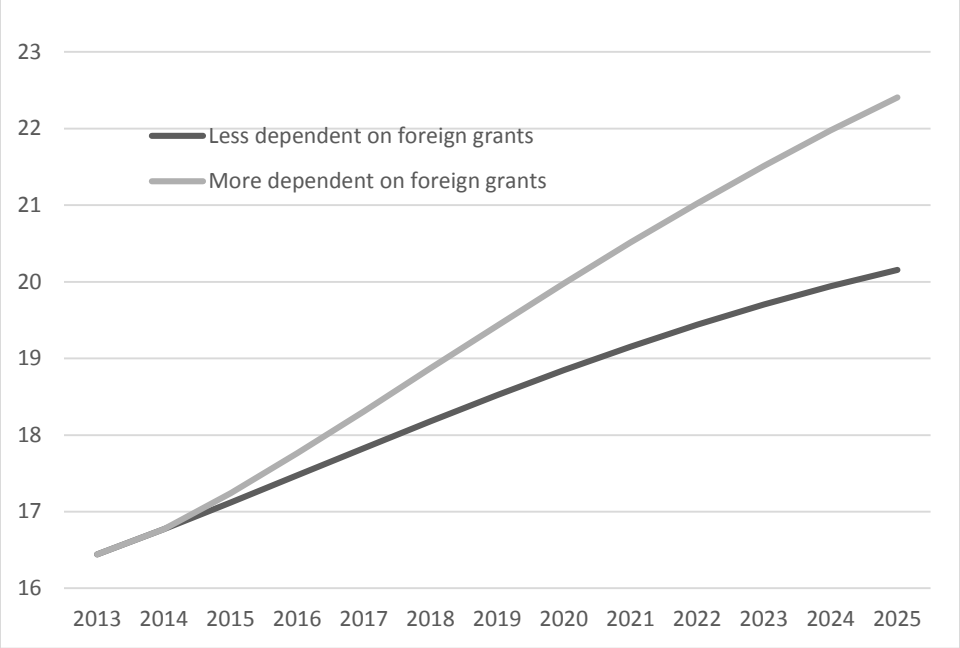
Source: The dynamic CGE model of Rwanda.

Figure C.3 Total investment growth rate (%)



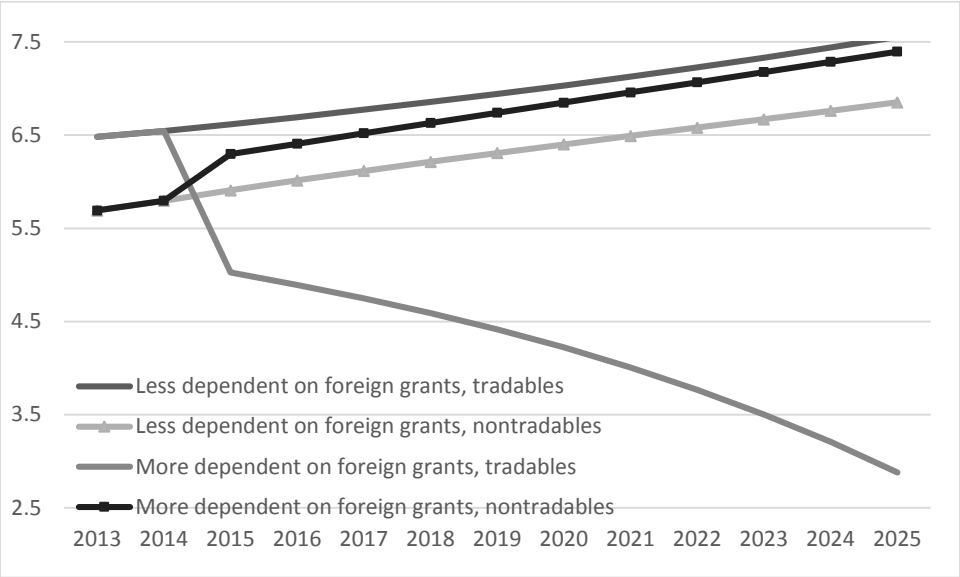
Source: The dynamic CGE model of Rwanda.

Figure C.4 Share of trade deficit in gross domestic product (%)



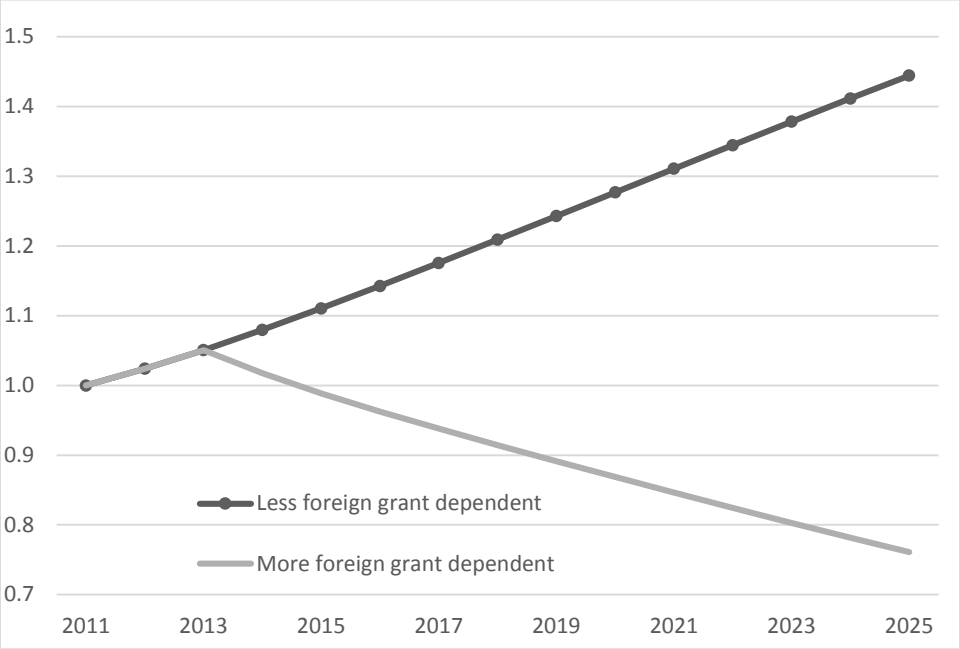
Source: The dynamic CGE model of Rwanda.

Figure C.5 Growth rate of tradable and nontradable gross domestic product (%)



Source: The dynamic CGE model of Rwanda.

Figure C.6 Incomes of the closed household relative to the open household, base year normalized to 1.0



Source: The dynamic CGE model of Rwanda.

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