Moving to the Adjacent Possible: Discovering Paths for Export Diversification in Rwanda

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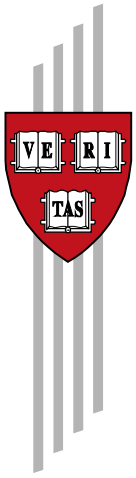

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Abstract: How can Rwanda, which currently has one of the lowest levels of income and exports per capita in the world, grow and diversify its economy in presence of significant constraints? We analyze Rwanda's historical growth and trade performance and find that Rwanda's high transportation costs and limited productive knowledge have held back greater export development and have resulted in excessive rural density. Three basic commodities – coffee, tea, and tin – made up more than 80 percent of the country's exports through its history and still drive the bulk of export growth today. Given Rwanda's high population density and associated land scarcity, these traditional exports cannot create enough jobs for its growing population, or sustainably drive future growth. Rwanda needs new, scalable activities in urban areas. In this report, we identify a strategy for greater diversification of exports in Rwanda that circumvents the key constraints and is separately tailored for regional and global export destinations. Our results identify more than 100 tradable products that lie at Rwanda's knowledge frontier, are not intensive in Rwanda's scarce resources, and economize on transportation costs. Our analysis produces a vision of a more diversified Rwanda, which can be used as a guide for investment promotion decisions. We illustrate an approach that can be applied to other settings in order to identify opportunities for export diversification that take seriously local constraints and external market opportunities.

Keywords: Rwanda, diversification, structural transformation, product space, economic complexity, binding constraints, transportation costs.

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Summary

In the past two decades Rwanda has made a remarkable recovery. During this period GDP per capita has grown on average 8 percent per year, among the highest rates on the African continent. Human development indicators have shown spectacular improvement. The Government of Rwanda has introduced bold reforms to Rwanda's legal, regulatory, political, and administrative institutions. In the international arena Rwanda has taken on the role of a model for development practice elsewhere. The question facing Rwandan policymakers now is: How can growth be sustained?

In this report we argue that in order to achieve sustained growth, *Rwanda needs to grow and diversify its export products and destinations and develop new, scalable activities in urban areas*. Our view is informed by an in-depth analysis of the main constraints that production activities in Rwanda face. One is the low availability of land. Rwanda is one of the most densely populated countries in the world with one of the lowest levels of land per capita. Meanwhile, subsistence agriculture is still the primary economic activity of nearly 80 percent of Rwandans. The reliance on land will need to be lessened in order to provide employment opportunities for Rwanda's growing population. The second key constraint is high transportation costs, which result from under-developed infrastructure and the fact that Rwanda is landlocked. Despite these costs, Rwanda's current trading partners are distant countries. Meanwhile its region accounts for less than 10 percent of total exports. The third constraint is relatively low existing levels of productive knowledge.

We describe a two-pronged strategy to achieve the goal of export growth and diversification while *circumventing the main constraints facing the country*. One aspect of the strategy is targeted at export opportunities in global markets and the other at the regional market. In both cases, we start by identifying products that are not intensive in the use of land and natural resources, which are Rwanda's scarcest factors. Second, we identify products that push the limits of Rwanda's productive knowledge while taking into account how far it can "jump" given the capabilities it has today. Third, we identify separately i) relatively less complex, low-transportation cost products, which can be targeted at distant markets and ii) relatively more complex, higher-transport cost products that are currently imported intensively by countries near Rwanda in which Rwanda has the opportunity to become a local supplier.

The results of our analysis identify more than one hundred new products that meet the strategic criteria of being non-resource intensive, at the boundary of Rwanda's productive knowledge, and feasible in terms of transportation-cost. Focusing on the global market, we identify the greatest number of opportunities in processed agricultural products, specialized textiles, footwear and garments, and relatively simple manufacturers (of metal, wood paper). These sectors can use local inputs, thus minimizing the reliance on imports. For the regional market, we the largest number of opportunities in machinery and chemicals related to the agricultural sector (e.g. simple agricultural and food processing machinery and parts, agrochemicals), construction

materials, and paper and plastics-based products. These products present a larger push in terms of capabilities and open up avenues for future diversification.

In this report, we review the growth story of Rwanda and perform an analysis of the key constraints facing producers in the country. The conclusions of this analysis inform our strategy design. Next we introduce the Product Space and Economic Complexity methodologies and describe Rwanda's position in the product space today. Putting strategy and methodology together, we identify new products and export destinations that meet the strategic criteria. We present a vision of a future product space of Rwanda. Finally, we conclude by discussing government policies that can assist Rwanda in developing the right environment and capabilities that these newly identified industries require.

1. The History of Growth in Rwanda: A Tale of Three Commodities

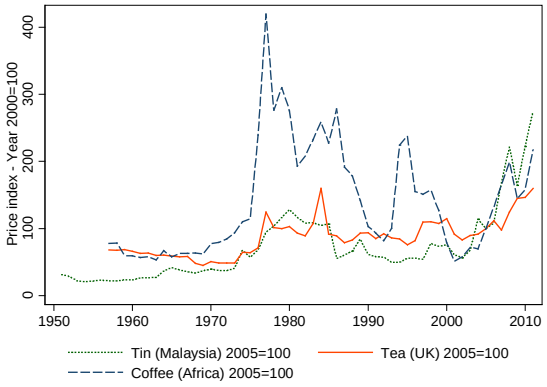
Rwanda's production and export patterns today still reflect to a large extent the circumstances of the country's history. The "land of the 1,000 hills" – a small, landlocked country with a hilly terrain and high elevation – Rwanda historically enjoyed higher rates of population growth than other countries in its region as altitude provided a natural shield against tropical diseases such as malaria and the relatively favorable climate provided good conditions for certain types of agriculture (Prunier, 1995). Traditionally Rwandans earned their living through small-scale farming and the herding of cattle. While it provided certain benefits, its landlocked location and high elevation also rendered Rwanda relatively isolated and commercial and trade linkages were underdeveloped.

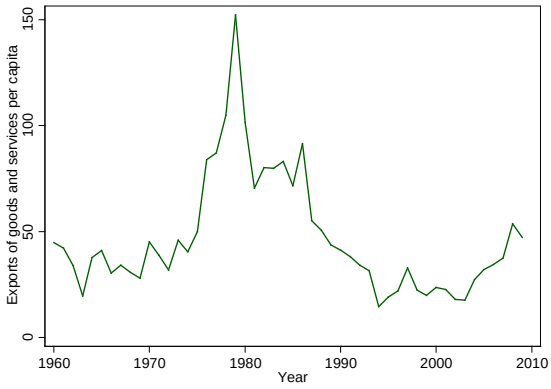
German and later Belgian colonialists introduced coffee and tea farming to Rwanda in the early 20th century and established the commercial linkages to the distant markets for these goods. Modest mining deposits (tin and tungsten) were also discovered during the colonial period and mining in commercial quantities began in the 1930s. Thus coffee, tea, and minerals – non-perishable goods that do not require fast shipment – became Rwanda's staple exports. When Rwanda was granted independence from Belgium in 1962, the majority of Rwandans were employed in subsistence agriculture as before the colonial period.

In the decades that followed independence, the economy changed little. What industrialization occurred in mining and cement production was largely state-owned. By 1989 more than 90 percent of the Rwandan population was still employed in agriculture. Compared to the countries in its region Rwanda was the least urbanized, with less than 5 percent of the population living in cities. Meanwhile, Rwanda's population density had climbed to one of the highest levels in the world as fertility rates remained above 8 children per woman until well into the 1980s.

Dependence on a few commodities for its exports represents a dangerous combination for Rwanda, making the country vulnerable to commodity price changes and weather shocks. Figure 1 shows how closely tied Rwanda's exports are to the prices of three commodities: coffee, tea, and tin. During the 1970s these benefitted from a price boom and Rwanda recorded some of its highest growth rates in GDP per capita. However in the 1980s the price of coffee plummeted (Figure 1, left). One of Rwanda's main tin mines closed. In the late 1980s a series of unusual weather patterns caused a small-scale famine in the countryside. As a result, exports of goods and services fell precariously from a high of 21 percent of GDP in 1979 to a low of 6 percent of GDP in 1990 (Figure 1, right). By the early 1990s Rwanda was facing very difficult economic times. These economic hardships exacerbated the political and social tensions that existed in Rwanda which ultimately lead to conflict and the tragic events of the Rwandan genocide in 1994.

Figure 1: Prices of coffee, tea, tin (left). Exports of goods and services per capita (right)





Source: IMF, International Finance Statistics.

Source: World Development Indicators (WDI).

2. Rwanda Today: Favorable Trends and Remaining Constraints

Favorable Trends

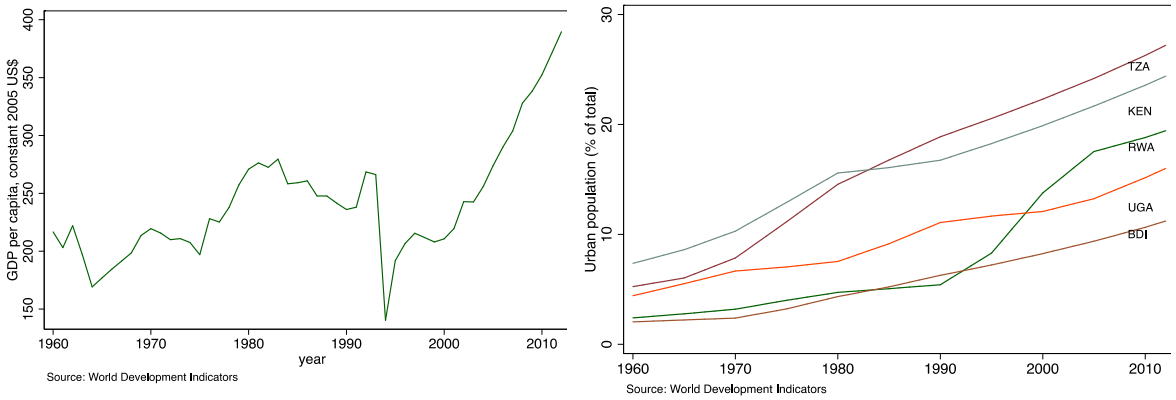
Recovery and catch-up: Since the end of conflict Rwanda has recorded significant achievements. It has undergone a period of recovery and growth. GDP per capita has almost doubled from 2000 to 2010 (Figure 2, left), surpassing pre-conflict levels by 2005. On average real GDP grew by close to 8 percent per year, placing Rwanda among the fastest growing countries on the African continent. Yet despite this remarkable performance Rwanda still ranks among the 25 poorest countries in the world.

Population dynamics: Rwanda is also seeing a demographic shift with a moderation in population growth. The country's average fertility rate has declined from 8 children per woman in the 1980s to 5 children per woman in the 2000s. People are increasingly leaving the countryside and moving to cities. The share of population living in urban areas has risen from 5 percent in 1990 to 19 percent in 2011 (Figure 2, right). The least urbanized country among its neighbors in 1990, Rwanda now ranks ahead of Burundi and Uganda. Kigali has grown in size from roughly 250,000 inhabitants in 1994 to close to one million in 2009. While such rapid urbanization brings about certain challenges, it is suggestive of a process of modernization.

Human development: The recent period of reform has also recorded significant achievements in human development. The cumulative human development index (HDI) has risen from 0.31 in 2000 to the Sub-Saharan average of 0.43 in 2010. Health indicators, including life expectancy and infant mortality have improved significantly and are tracking to meet *Vision 2020* targets. Educational indicators such as enrollment rates, training of teachers, and gender equality in schools are also showing clear upward trends. However extreme poverty headcounts remain below targets, especially in rural areas. The Gini index has also shown deterioration, moving counter to targets. Nevertheless Rwanda

now ranks second in East Africa region on indicators of human development, including welfare, health, and education (IIAG, 2010).

Figure 2: GDP per capita (2005 US$), 1960-2010 (left). Urbanization rate in Rwanda and Neighboring Countries (right)



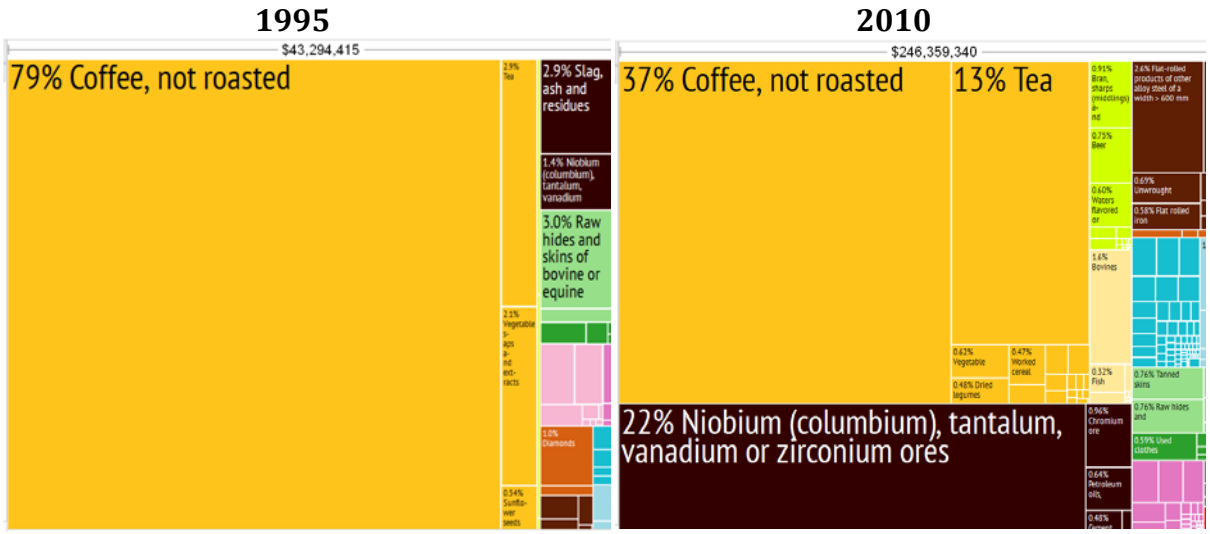
Institutional reform: Another significant trend of the post-conflict period has been a focus on institutional reform. The Government of Rwanda has focused on growing administrative capacity, implementing reforms, and removing barriers to business. It has established institutions for the promotion of various economic sectors, SMEs, and exports housed under the Rwandan Development Board. Among its key achievements is Rwanda's designation as the third easiest place to do business in Africa and second "top global reformer" in the World Bank's *Doing Business* rankings.[1] The 2011 Ibrahim Index of African Governance (IIAG) ranked Rwanda fifth overall and first among 12 countries in East Africa on measures of quality of the business environment and of public management.[2]

Key Challenges

Structural Transformation: Despite recent achievements it remains far from assured that Rwanda has successful embarked on a *sustainable* growth path. Subsistence farming still employs close to 80 percent of the population.[3] A rekindling of traditional export activities fueled recent growth and as Figure 3 shows, little progress was achieved as of 2010 in diversifying exports away from these basic commodities. Moreover, at less than US$50 per capita, Rwanda still has one of the lowest levels of exports in the world. Growing and diversifying its manufacturing base is a critical next step in order for Rwanda to achieve its *Vision 2020* targets.

[1] Rwanda Development Board press release: http://www.rdb.rw.
[2] 2011 Ibrahim Index of African Governance (IIAG): http://www.moibrahimfoundation.org.
[3] Calculations based on data from the National Institute of Statistics of Rwanda "Gross Domestic Product by Kind of Activity at constant 2006 prices." The share of Industry rose from 12 to 14 percent. Employment figures from the 2012 Labor Force Participation Report.

Figure 3: Composition of Goods Exports in 1995 and 2010



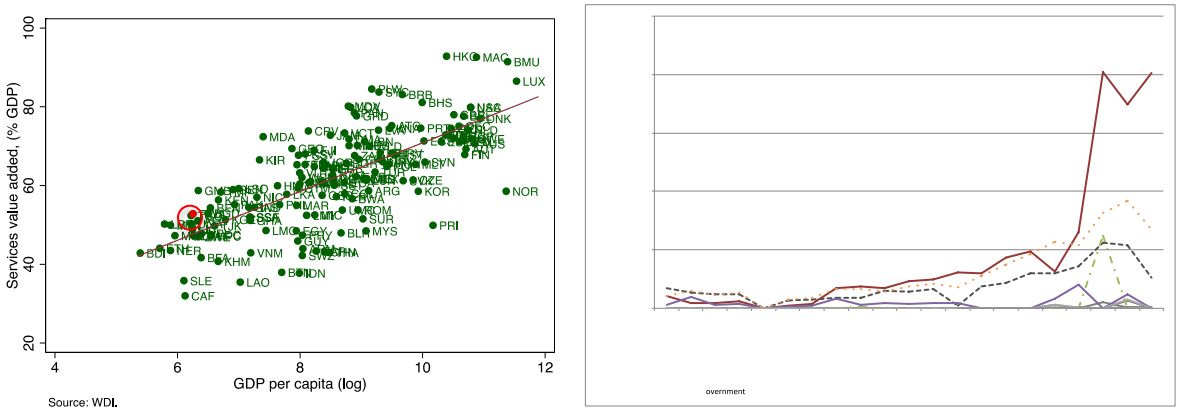
Source: *The Atlas of Economic Complexity* (www.atlas.cid.harvard.edu).

To be sure, growth of the services sector will also play a large role in economic transformation. Most countries, as they develop, increase the share of services in value added (Figure 4, left). Indeed, in Rwanda the share of services in GDP has increased from 41 percent to 49, although the recent growth was mostly fueled by tourism and government services, while growth in the target sectors of ICT, business services, and finance has been less than hoped (Figure 4, right).

However, rather than leaping directly from an agrarian into a predominantly service-based economy, most countries transition, building up a strong manufacturing base while growing the services sector. Rwanda already ranks high in its share of services in GDP relative to countries at its income level. Indeed Rwanda has a comparative advantage in services because they rely lass on land, natural resources, and physical transportation infrastructure while leveraging Rwanda's more abundant factors, including its human capital, good institutions, and location. At the same time, given its very low starting point, greater development of the manufacturing base is also critical.

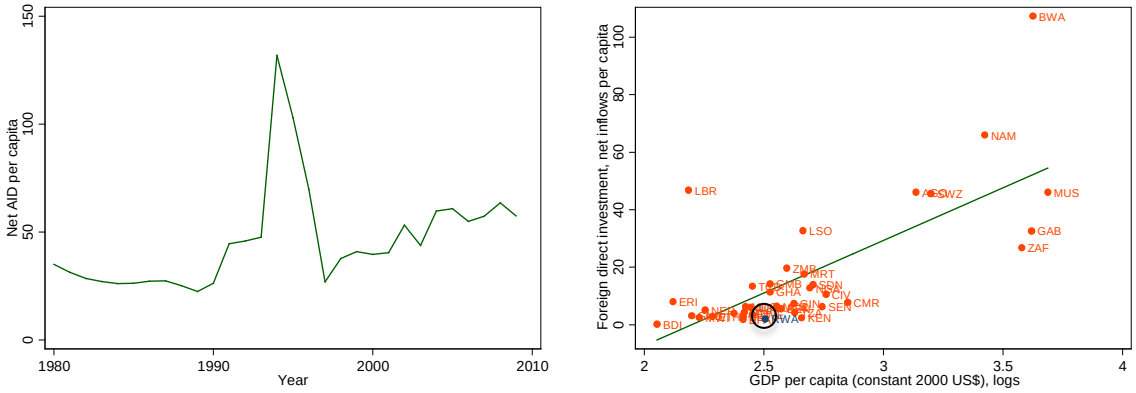
Increasing Private Investment: As in the past, recent growth was fueled to a large extent by two sources: traditional exports and foreign aid. While exports have grown, imports have grown even faster and amounted to US$1.4 billion in 2010. The resulting hole in the current account is being plugged by foreign aid, which has been rising in recent years and at roughly US$50 per capita parallels the size of exports (Figure 5, left). Foreign direct investment stocks per capita, on the other hand, are among the lowest levels of any country in Sub-Saharan Africa (Figure 5, right).

Figure 4: Share of Services in Value added Globally (left) and Rwanda's exports of services (right).



Source: WDI and World Bank service exports data. In left graph, Rwanda is highlighted in red.

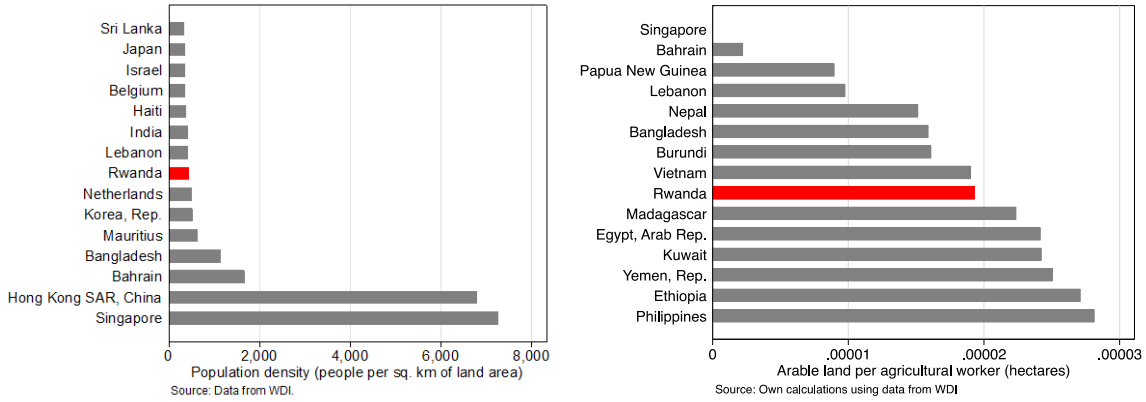
Figure 5: Net aid per capita (left) and New FDI stocks, 2005-2010 avg. (right)



Key Constraints

1. Scarcity of land / land density: With a small land area, Rwanda is one of the most densely populated countries in the world (Figure 6). Most of the population still resides in the countryside and is engaged in agriculture. The high rural density and low level of land per agricultural worker represent a natural limit to the ability of land-based activities to provide jobs and incomes for a majority of Rwanda's growing population. A sustainable growth strategy needs to find ways in which Rwanda can develop new activities that are not intensive in their use of land and natural resources.

Figure 6: Population density - top 15 countries in the world (left). Arable land per agricultural worker - bottom 15 countries in the world (right).

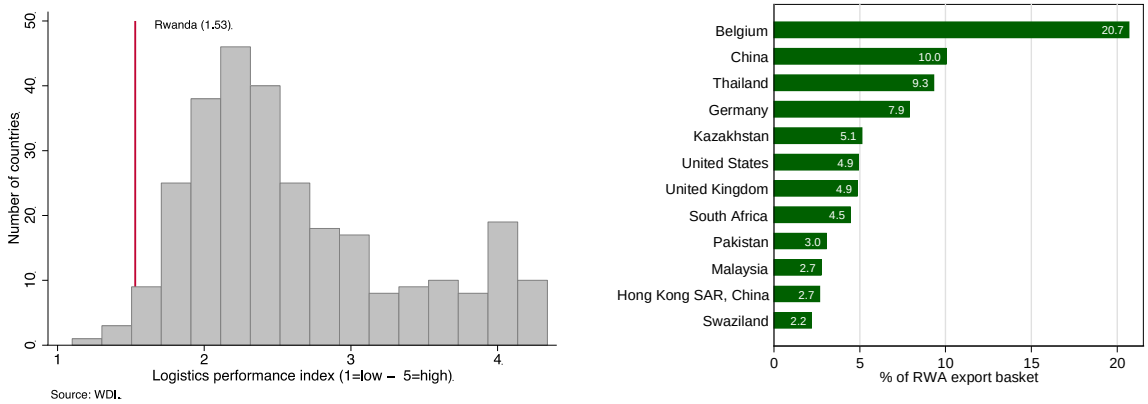


2. Infrastructure: Currently Rwanda has one of the highest costs of transportation and electricity in the world. Electricity costs more the 20 cents per kwh. The country is landlocked and nearly 1,400 kilometers removed from the nearest seaport in Dar-es-Salaam, Tanzania. There are few alternatives to costly and slow road transport. The World Bank's logistics performance index, a summary measure of the quality of trade and transport-related infrastructure, ranked Rwanda 139th out of 155th countries in the world in 2012 (Figure 7, left). Its infrastructure currently constraints what goods Rwanda can export. For example, perishable goods or goods that require fast market access (e.g. fresh fruit, flowers) are infeasible in absence of major infrastructure investments (air shipment).

While moving goods is costly, most of Rwanda's current exports travel to distant markets (Figure 7, right). The majority of Rwanda's coffee is exported to Switzerland, Germany and the U.S.; tea travels through Kenya to the U.K and Pakistan; and most of the metal exports are destined for China (Gathani & Stoelinga, 2012). Meanwhile, exports to the nearby markets of East Africa, which could incur lower transportation costs, account for only 10 percent of Rwanda's total exports.

3. Productive knowledge: The third major constraint in Rwanda is the existing level of productive knowledge. Productive knowledge is the know-how that people and organizations acquire through experience and over time that is used in the process of production. While it is difficult to measure productive knowledge directly it can be inferred by analyzing the variety and sophistication of the products and services that a country currently makes (Hausmann et al., 2011). Historically Rwanda has produced relatively simple agricultural and mineral commodities. As a result, the amount of productive knowledge that is currently available is relatively limited and it constraints what new products and activities Rwanda will be able to discover.

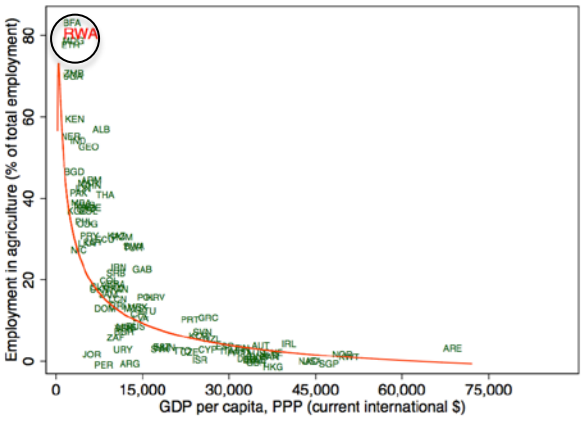
Figure 7: Quality of trade- and transport-related infrastructure index, 2012 (left). Top Destinations of Rwanda's Exports (right)



The Strategic Implications

Having identified the key constraints to greater export growth and private investment, here we outline a strategy that we will leverage in order to identify the activities that will be best able to circumvent these constraints. Such activities will more naturally flourish even as the government takes actions to lessen the identified constraints (Hausmann, Rodrick, and Velasco, 2008).

Figure 8: Employment in Agriculture and GDP per capita, global trend



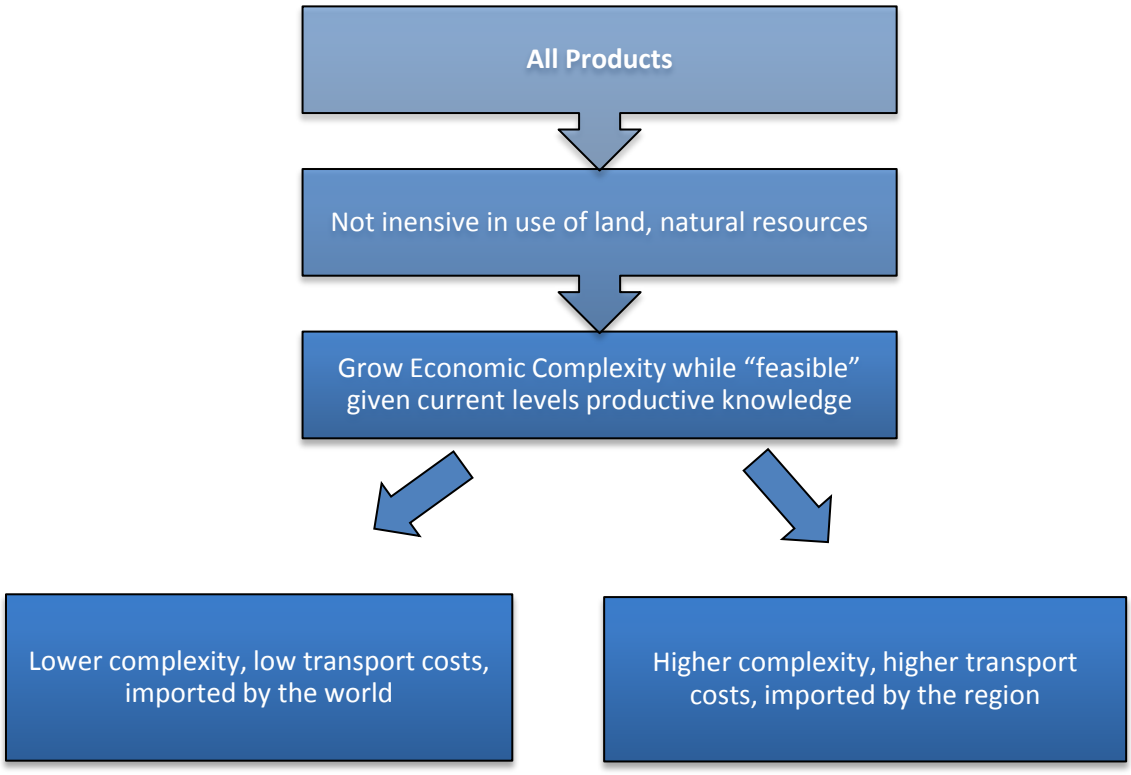
First, future industries should move away from rural, land-based, and natural-resource-based activities. Today, the share of Rwanda's population engaged in agricultural employment is extremely high, even compared to countries at its own low-income level (Figure 8). Wealthy countries have inevitably reduced the share of their population employed in agriculture. To achieve this, Rwanda needs to increase agricultural productivity and create scalable activities in urban areas, which will provide employment and increasingly draw people to cities. Some such activities can use agricultural production as an input, but the goal is to add value to the basic agricultural products through processing, packaging, and exporting.

Second, the government's strategy should be mindful of where Rwanda's current capabilities lie and grow the extent of productive knowledge in Rwanda while not overstretching. Rwanda's current productive knowledge is mostly related to the growing

of agricultural goods and herding of animals. But there exist more complex goods that leverage this know-how, while growing productive knowledge, for example the production of processed foods and beverages, simple agricultural machinery, or textiles. Another source of productive knowledge comes from Rwanda's production experience in metals. Products and articles of metals and related industries are also within Rwanda's knowledge frontier.

Finally, any export strategy needs to be attune to the *markets* that Rwanda will sell in. Here, we believe the best strategy for Rwanda differs as it competes in global versus its regional market. In the global market, Rwanda will for the most part supply simple goods, as it not yet in the position to complete in higher-complexity sectors. Secondly, these goods need to be low-transport cost intensive given the high costs and slow travel times. However, in its region, Rwanda faces less competition and could make inroads into somewhat more complex products. Also, here it can gain an edge as a lower-cost supplier of goods that the region imports from afar and for which transport represents a larger share of cost. Figure 9 (below) visualizes the key aspects of our proposed strategy. The next section of this paper summarizes the theory of economic complexity and the product space that we will leverage to identify the new activities that satisfy the strategic criteria outlined.

Figure 9: A Strategy for Export Growth and Diversification in Rwanda



3. Data and Methodology

Dominant models of economic growth assume that growth requires the accumulation of physical capital, human capital, and increases in the productivity of these factors of production. However to this day we do not fully know what exactly constitutes or determines productivity. Hausmann and Hidalgo (2011) introduce the idea that the productivity of a country can be understood by looking at the *ubiquity* and *complexity* of the goods that it is able to produce. To observe what countries produce the authors use international trade data complied by the United Nations (Comtrade). Their analysis of the data over a long time period shows that as countries grow, they diversify their export baskets. That is, rather than abandoning what they made in the past, countries continue to add new products to their export mix. In general, developed economies export a wide range of products while developing countries export only a few. Moreover, developed countries tend to export products that are relatively complex and rare (made by few other countries) while developing countries tend to export products that are relatively simple and ubiquitous (made by many countries).

To explain this pattern in the data the authors develop the Scrabble metaphor. Just as in Scrabble words require letters, production of each good or service requires a specific number of (tradable and non-tradable) capabilities. Countries are able to make only those products for which they have the entire range of requisite capabilities.[4] Like in Scrabble some words are short and require a few common letters, so some products (e.g. cotton) require few simple capabilities. On the other hand, just like long, complex words often require many and relatively rare letters, rare, complex products (e.g. airplanes) require many capabilities.

In order to formalize these hypotheses the authors develop a measure called the *Product Complexity Index (PCI)*, which measures how complex a product is, i.e. how many capabilities it requires. Then the authors go on to infer how much productive knowledge is present in a country by observing what products it currently is able to make and how complex those products are. They develop a measure called the *Economic Complexity Index (ECI)*, which summarizes on average how complex the product mix is that a country makes.[5] Countries with a high value of ECI produce a wide range of relatively complex products, while countries with low ECI produce few and relatively simple products.

Hausmann et al., (2011) subsequently show that the ECI is highly correlated with not only of how wealthy a country is today but also how fast it grows in the future. The authors find that on average countries whose export baskets are more complex than their income would suggest have tended to grow faster and those whose exports are less

[4] While the tradable capabilities (e.g. finance, intermediate inputs, payment processing services) can be imported, non-tradable capabilities (e.g. land, rules, regulations, infrastructure) have to be present locally in order for a good to be made.

[5] Note, the ECI and PCI are both normalized measures with mean zero and standard deviation of one. The ECI is unique to a country-year and the PCI is unique to a product-year. These measures have no absolute interpretation but rather can be used to rank countries and products according to their complexity.

complex than their income would suggest have tended to grow slower. Therefore what countries produce today matters to future growth. Theoretically, the reason why this should be the case is if production involves a learning process that has positive externalities – i.e. that facilitates future development of other products and industries. Then what a country makes today helps to determine what it knows and what it can lean to do tomorrow.

To explore the hypothesis that production involves learning externalities Hausmann and Klinger (2006) and Hidalgo et al. (2007) developed the product space. It is a network that visualizes all products that countries export whereby products that are more frequently co-exported are more strongly connected and lie closer to each other.[6] Mapping the position of many countries in the product space over time, the data shows that *new export products tend to emerge close to existing products in the product space* (Hidalgo et al., 2007). As a result, countries located in dense parts of the product space with many products nearby find diversification easier than countries producing isolated items that are peripheral in the product space.

This empirical finding lends strong support to the hypothesis that production involves learning and that the process of growth and diversification does not follow a random path, but rather, that it is incremental and to some extent predictable. Moreover, a country's particular starting point in the product space provides important clues as to what products and industries it is in a good position to develop next – specifically, it is more likely to move to the products that are nearby.

To formalize the concept of how far or nearby a country is to a new product, the authors develop a measure of *Distance*. The proximity between any two products can be calculated as the minimum conditional probability that a country that exports one also exports the other. A country's *Distance* from a given product, for example Product A, is calculated by summing the proximities to product A from all products in which the country does *not* have RCA and dividing that by the sum of the proximities to A from all products.[7] Metaphorically if between each pair of products there exists a path, the number of paths a country can travel to reach a given product and the shorter these paths are, the lesser a country's *Distance* to that product is.

Finally, to formalize the idea that the new products that a country develops affect its future opportunities for diversification, the authors introduce a measure of *Opportunity gain*. It is calculated as the change in *Opportunity value* from developing RCA in a new product, where *Opportunity value* is a measure that summarizes the value of a county's strategic position in the product space (how near or far it is from complex products).[8] A new product can be strategically valuable if it "opens doors" for future diversification – i.e. if it decreases the distance to other strategic products. Products that allow a country to

[6] For example, since relatively many countries export both cocoa and flowers, these two products appear close in the product space. One the other hand, because few countries export both aircraft and bananas, these two products are distant in the product space.
[7] For a detailed description of the methodology see Hausmann et al. (2011).
[8] Ibid.

access parts of the product space with multiple connections might prove pivotal in the long-term diversification process. *Opportunity gain* is a measure designed to capture how much a new product will improve the country's position in the product space.[9]

Description of the Data

The primarily data used to map the product space is international trade data from the United Nations. Here we use two related versions: i) data at the Harmonized System 4 digit classification level (HS4 data) compiled by the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) and ii) data at Standard International Trade Classification 4 digit level (SITC4) published by the United Nations. Both data provide information of the exports of more than 200 countries at the product level. The advantage of the HS4 data is that it is more granular (disaggregated into 1,240 different products) than the SITC data (774 different products). However the SITC data is available for a longer time period (1964-2010). In this paper we mostly use SITC4 data but complement it with HS4 data for a more granular view of Rwanda's product categories.

There are three main drawbacks to the data. First, it is data on exports of goods and not aggregate production. Thus it is not able to capture the productive knowledge used in the production of non-traded goods or services. In the case of Rwanda, goods exports represent only 5 percent of GDP. Thus the analysis of exports will not be able to fully capture the knowledge that exists in Rwanda to the extent that it is expressed only in the production of non-traded goods or services. However since the aim of this report is to identify opportunities for the diversification of Rwanda's exports, looking at export data is a natural choice. Moreover the fact that certain locally produced goods are not exported suggests that a country may not yet be very efficient or competitive at producing them.

Second, countries may also export products they do not make. While many countries' customs offices clean data from re-exports not all do so with a high degree of accuracy. To circumvent this issue in our analysis we require a country to have a significant presence in a product to assume that it makes it. We say a country has a significant presence in a product if its *revealed comparative advantage* (RCA) is greater than one. RCA is defined as the ratio between the share of a product in the exports of a country and the share of that product in the exports of the world, per Balassa (1964). However, some countries which have very low levels of exports overall may achieve RCA even in some products that are solely being re-exported. In the case of Rwanda this may explain why a number of unexpected products appear in its export data (e.g. cars and other motor vehicles). Whenever possible we adjust for these irregularities.

Finally, the data include only goods and not services. This is an important drawback, as services are becoming a rising share of international trade and in the case of Rwanda, service exports are expected to make a significant contribution to overall export growth. Unfortunately there are no international datasets on services comparable to the one that exists for goods and since existing services data is not sufficiently granular, we are not yet able to integrate it into the product space. As a result, the discussion in the remainder of this paper will be largely limited to the exploration of new goods exports.

9 Formally, it is calculating by subtracting the country's current Opportunity Gain score from the Opportunity Gain score calculated after adding the new product (with RCA) to the current export basket.

4. The Product Space of Rwanda

In order to assess the current extent of productive knowledge in Rwanda and what lies nearby we analyze Rwanda's product space (Figure 10).[10] The colored nodes represent products that Rwanda exported with revealed comparative advantage (RCA) greater than one in 2010. The pale nodes are those in which Rwanda did not have a significant presence (RCA < 1) in 2010. The color of each node corresponds to its "community" – a grouping of products requiring related productive knowledge, similar to the notion of a sector.[11] Some communities naturally cluster more than others (e.g. machinery, chemicals, electronics, textiles). Clustering suggests that the products in these communities share a large amount of the requisite knowledge. On the other hand many natural resource products and agricultural products are less inter-connected and more peripheral in the product space. This suggests that the inputs required for the production of these goods are less central to the production of many other goods.

The broad takeaway from Rwanda's current position in the product space is that it is relatively sparse, peripheral, and scattered. But it also provides some clues as to emergent activities and possible future paths of diversification. As of 2010, Rwanda had RCA in less than 40 products across a number of communities. Mineral products, the country's largest export sector by value, have a peripheral location in the product space (top right, bottom right, center left), meaning that they do little to facilitate diversification into other products. Processed raw materials such as Rwanda's exports of flat rolled steel products and of cement are somewhat more centrally located suggesting they are more strategic in terms of building productive know-how. In the bottom right and top right of the product space we find Rwanda's staple exports of tea and coffee. While these two products are also relatively peripheral, scattered nearby coffee are various processed and non-perishable vegetable products (potatoes, frozen vegetables, dried legumes, vegetable oils) as well as a number of animal, fish and processed cereal products (bovines, sheep, animal fats, starches, flours), a few of which already show RCA. In the processed foodstuffs category we see emergent exports of beer, natural, and flavored waters. Consistent with our claim that transportation infrastructure is one of the key constraints, Rwanda's current export portfolio features almost exclusively *non-perishable* edibles, which do not rely on fast access to markets.

[10] Note that there is one product space on which countries' specific production is superimposed (via the colored circles that represent RCA > 1) rather than a product space for each country.

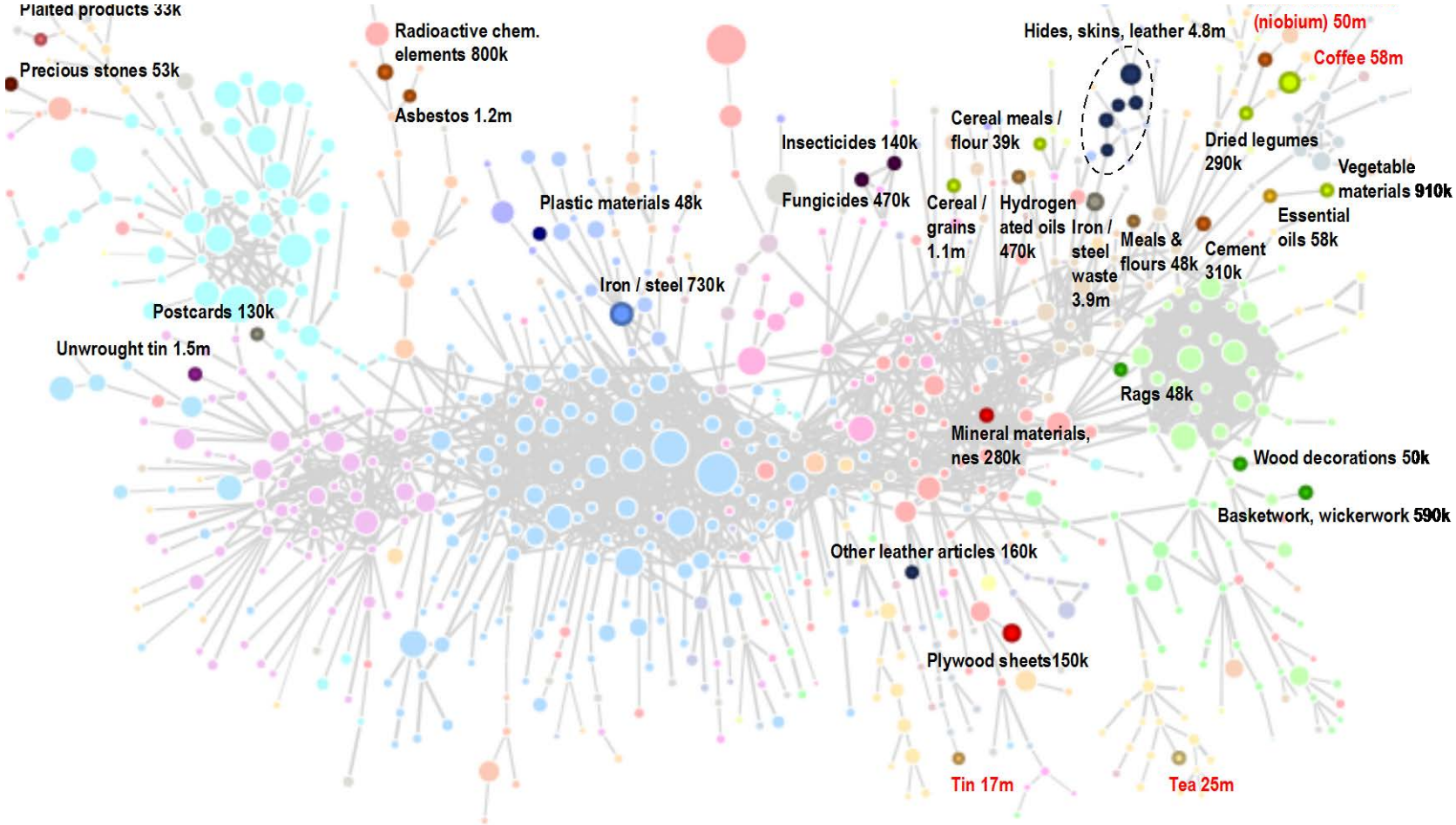
[11] Per Hausmann et al., there are 34 communities in the product space: 1 "Agrochemicals" 2 "Aircraft" 3 " Animal Fibers" 4 "Beer, Spirits and cigarettes" 5 "Boilers" 6 "Cereals and vegetable oils" 7 "Chemicals and health related products" 8 "Coal" 9 "Construction materials and equipment" 10 "Cotton, rice, soy beans and others" 11 "Electronics" 12 "Fish & Seafood" 13 "Food Processing" 14 "Fruit" 15 "Garments" 16 "Home and office products" 17 "Inorganic salts and acids" 18 "Leather" 19 "Machinery" 20 "Meat and eggs" 21 "Metal products" 22 "Milk & cheese" 23 "Mining" 24 "Misc. Agriculture" 25 "Not classified" 26 "Oil" 27 "Other Chemicals" 28 "Petrochemicals" 29 "Precious Stones" 30 "Pulp and paper" 31 "Ships" 32 "Textile & Fabrics" 33 "Tobacco" 34 "Tropical tree-crops and flowers." Each is indicated in the product space with a unique color as shown in this legend:

Rwanda also has RCA in a number of simple leather products (skins, hides, furs). Although the cumulative export earnings of these products amounted to less than US$5 million in 2010 (following a steep decline and closure of certain facilities), Rwanda may be able to leverage some of the know-how used by this sector for its future diversification. Footwear and textiles are relatively nearby in the product space, suggesting they can leverage some of the existing capabilities. Indeed, Rwanda already has RCA in exports of certain types of footwear, sacks, bags, and woven fabrics.

The product space also points to a number of emergent sectors where entrepreneurs are making inroads and which Rwanda may be able to leverage for future diversification. The miscellaneous product category features artistic items such as paintings, instruments, and sculptures. Rwanda also shows some presence in a number of other decorative products including ceramic tableware, basketwork, wood statues, and postcards. Also emerging are beauty, makeup, and hair products, soap, as well as several agrochemicals. While these exports are still too small for Rwanda to be considered a competitive exporter, they provide important clues about how entrepreneurs are approaching the problem of exporting from Rwanda. Notably *almost all of the non-traditional products conform to three criteria: they are not intensive in their use of land and natural resources, they are non-perishable and not logistically challenging, they are not overly sophisticated or complex.*

Overall when compared to its neighbors Rwanda is more diversified than Burundi and the Democratic Republic of Congo but less diversified than Uganda, Kenya, and Tanzania (Table 2). Compared to its neighbors, Rwanda is currently more specialized in leather, minerals and metals, and miscellaneous items but less specialized in agricultural products, wood products, textiles, and animal products. The fact that other countries in its region have made inroads in these sectors suggests that the climate / locational conditions for these industries are favorable and that Rwanda should also be able to make greater progress in developing these export sectors, targeting them to the global markets. Meanwhile, just like Rwanda, the neighboring countries have few exports in some of the more complex communities, like machinery, electronics, and plastics. This lower level of existing competition in the regional market presents an opportunity for any country that can produce in these industries.

Figure 10: The Product Space of Rwanda (2010)



Source: Atlas of Economic Complexity. Exports data at the SITC4 level. For color legend, refer to Footnote 10. Largest exports are colored in red.

Table 1: Rwanda's exports with RCA (2010)

Category	Number of products in which Rwanda has RCA	Total number of products in category	Value of Rwanda's exports (US$ 000)	Percent of Rwanda's total Exports (%)
Mineral Products	11	66	125,611	35.5
Vegetable Products*	13	101	123,258	34.9
Transportation**	7	38	37,123	10.5
Miscellaneous	10	101	24,278	6.9
Machinery / Electrical	4	133	15,048	4.3
Metals and Metal Products	8	157	7,666	2.2
Textiles	6	149	3,715	1.1
Animals & Animal Products	2	44	3,486	1.0
Foodstuffs	4	56	3,479	1.0
Hides, Skins, Leather, Furs	6	21	3,242	0.9
Chemicals & Allied Industries	7	176	2,303	0.7
Stone / Glass	2	67	1,233	0.3
Wood & Wood Products	4	68	1,004	0.3
Footwear / Headgear	1	20	1,000	0.3
Plastics / Rubbers	1	43	909	0.3
Total	**86**	**1,240**	**353,353**	**100.0**

Note: Data at the HS4 level (CEPII) hence values differ from those recorded by the SITC4 level data.
* Include coffee and tea. **Includes re-exports of cars, trucks and armored vehicles.

Table 2: Number of exports with RCA, Rwanda and Neighbors (2010)

Category	Rwanda	Burundi	Kenya	Tanzania	Uganda	DRC
Vegetable Products	13	12	35	34	28	5
Miscellaneous	11	2	7	6	3	2
Mineral Products	10	5	14	19	9	9
Metals and Metal Products	8	1	11	14	16	5
Transportation	7	3	3	2	0	0
Textiles	6	7	27	28	6	0
Hides, Skins, Leather, Furs	6	6	6	6	7	0
Chemicals & Allied Industries	6	2	15	14	16	3
Machinery / Electrical	4	2	4	9	1	0
Foodstuffs	4	4	11	10	4	3
Wood & Wood Products	4	2	13	9	7	5
Stone / Glass	3	2	5	8	2	1
Animal & Animal Products	2	2	11	14	13	2
Footwear / Headgear	1	0	4	0	2	0
Plastics / Rubbers	1	0	1	2	2	1
Total	**86**	**50**	**167**	**175**	**116**	**36**

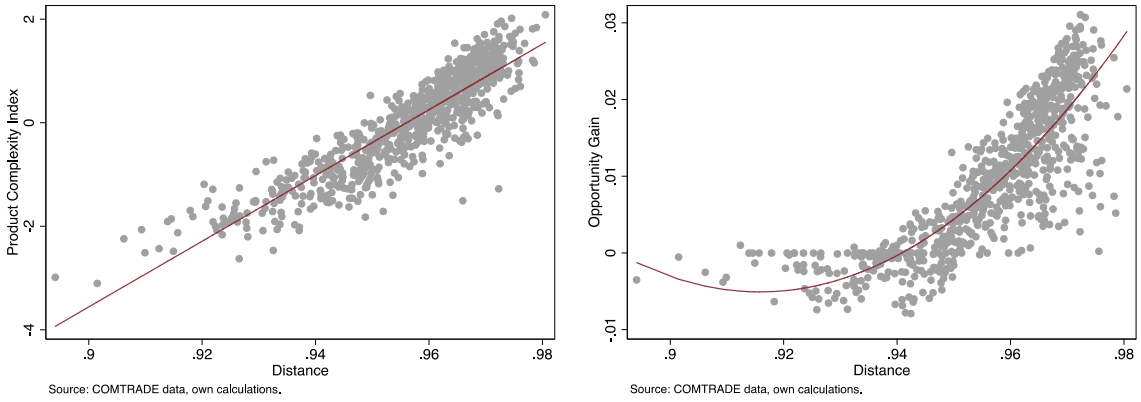
Note: Communities are sorted by largest to smallest for Rwanda. Source: Exports data at the HS4 level (CEPII).

5. Discovering New Products at Rwanda's Knowledge Frontier

Next we leverage the tools of the Economic Complexity framework to answer: what new products would increase the complexity of Rwanda's economy, resulting in a more diverse and attractive product mix, but lie sufficiently nearby Rwanda's current capabilities so as to be feasible? These "frontier products" will satisfy the following criteria: 1) They are more complex than what Rwanda already exports; 2) They are feasible given Rwanda's productive knowledge; 3) They open up paths to future diversification. In each case, we will also impose the criterion that the product shall not be intensive in the use of land and natural resources.

To identify "frontier products" we use measures of product complexity (*PCI*), *Distance* and *Opportunity gain* developed by Hausmann, Hidalgo et al. (2011) and described in Section 3. Optimally a country would diversify into new products that have the highest *PCI*, shortest *Distance*, and highest *Opportunity gain*. However, often there exits a trade-off between these three desired properties. For most countries the products that have highest *PCI* are also farthest away in terms of *Distance*. Similarly the products that deliver the highest *Opportunity gain* also tend to lie at greater distances. Figure 11 (below) illustrates this tradeoff in the case of Rwanda.

Figure 11: The Basic Tradeoff between Distance and PCI (left) and Distance and Opportunity Gain (right) for Rwanda

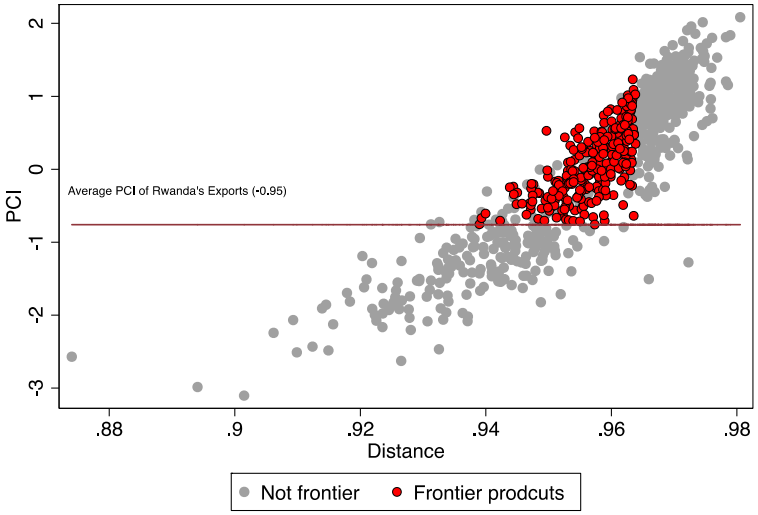


Note: Each dot represents a prodcut (SITC4 level data).

To identify product at Rwanda's knowledge frontier, we follow four consecutive steps: 1) Eliminate all exports of unprocessed natural resources and land-intensive agricultural commodities. Starting from 774 distinct products featured in the United Nations SITC4 trade data, this eliminates 66 products. 2) Eliminate all products with a *PCI* below the existing average *PCI* of the products that Rwanda's exports (which is -0.95, meaning that on average, products exported by Rwanda are roughly one standard deviation below the average *PCI* of all products exported by countries in the world). Thus, each of the remaining products, if developed, would increase the complexity of Rwanda's export basket. This exercise eliminates an additional 168 products that have

low *PCI*, leaving 540 products. 3) Use *Distance* to identify products that are more feasible given Rwanda's current position in the product space. While there is no clear cutoff to what *Distance* is feasible or not (with sufficient investment even large distances can be overcome), we use the median distance of the products in which Rwanda does not already have RCA as the cutoff. This filter eliminates the 50 percent of products that are more distant from Rwanda's current capabilities, leaving 270 products that are closer to Rwanda's current productive knowledge i.e. that are closer to its knowledge frontier. 4) Use *Opportunity gain* to eliminate any product that would not open up paths to future diversification. This eliminates three products that do not meet this threshold. Figure 12 (below) illustrates the products selected by the strategy in the context of the *PCI* / *Distance* tradeoff. The next seltion highlights the criterea by which we choose the markes and destinations for the selected products.

Figure 12: Identifying Products at Rwanda's Knowledge Frontier



Source: COMTRADE data, own calculations.

6. Discovering Market Opportunities – Matching Products to Destinations

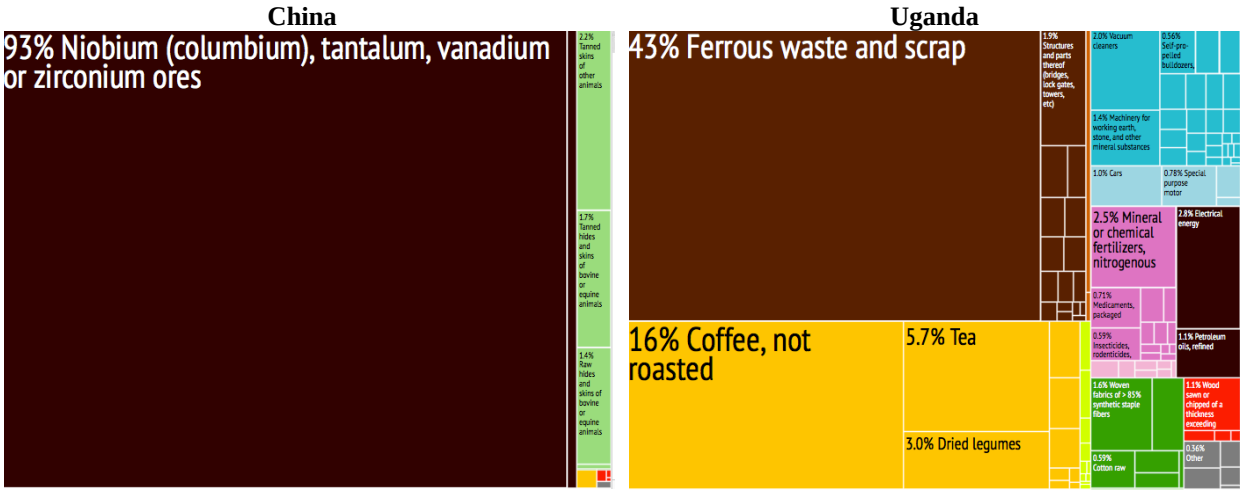
Having considered which non-resource intensive products lie at Rwanda's knowledge frontier, we now consider the demand side: In which markets can it be a competitive seller? Currently, the top export destinations for Rwanda's exports are countries in Europe (Belgium, Switzerland, Germany), Asia (China, Thailand, Pakistan), and the U.S. This orientation toward distant markets naturally constraints the type of goods that Rwanda can profitably export to those goods have relatively low transport costs. Moreover, given the high levels of competition in these markets, Rwanda's advantage as a low-income country is in relatively less complex-products.

While is can seek to grow its global market presence, Rwanda faces a huge opportunity to expand its exports by growing trade with its own region. Currently none of

the countries in Rwanda's region are amid the top destinations for its exports. Such a low degree of regional economic integration is unusual for a small country. For example the Netherlands, Switzerland, and Singapore have some of the highest degrees of regional trade integration in the world. Since their small domestic markets are insufficient to sustain industries that require scale, these countries leverage their location (close to larger markets) to become a hub for exports to the region.

Part of the reason why regional trade between Rwanda and neighboring countries is low is that the region on average imports relatively complex products, notably machinery, electronics, and chemicals since these are largely not supplied locally. Thus *in order to expand regional exports, Rwanda needs to venture into products of greater complexity*. Indeed, current export patterns already show a difference in the complexity of products that Rwanda exports to the regional market versus what it exports to the world. While Europe, Asia, and the United States import basic commodities from Rwanda, its regional neighbors import a greater variety of processed and semi-manufactured goods, including fertilizers, energy, fabrics, and wood products (Figure 13).

Figure 13: Rwanda's Exports to China and Uganda, 2010



Note: Data at the HS4 level (CEPII). Source: The Atlas of Economic Complexity.

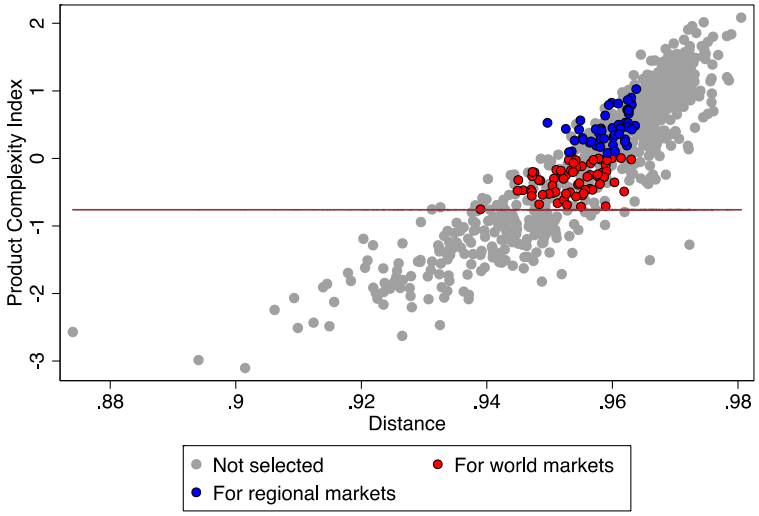
The key question is, which products that the region currently imports intensively is Rwanda is in a good position to supply? While these are likely to be products of somewhat higher complexity, there are few established producers of such products in local markets hence Rwanda would be competing against global imports. In order to gain an competitive edge in those import-intensive products, Rwanda should identify those for which transportation costs are relatively *high* because here Rwanda's proximity to its neighbors can play to its advantage in terms of lowering transportation costs relative to global imports.

These insights generate a set of criteria that can be used to match the products that are feasible in Rwanda to their most promising export destinations. Specifically in the

next two sections we leverage trade data, the product space, and transportation cost estimates in order to identify which of the frontier prodcuts:

1) Have low transportation costs and relatively lower complexity → these can be targeted at global markets
2) Are imported intensively by the region, have higher complexity, and higher transportation costs → these can be targeted at regional markets

Figure 14: Identifying Markets for Frontier Products



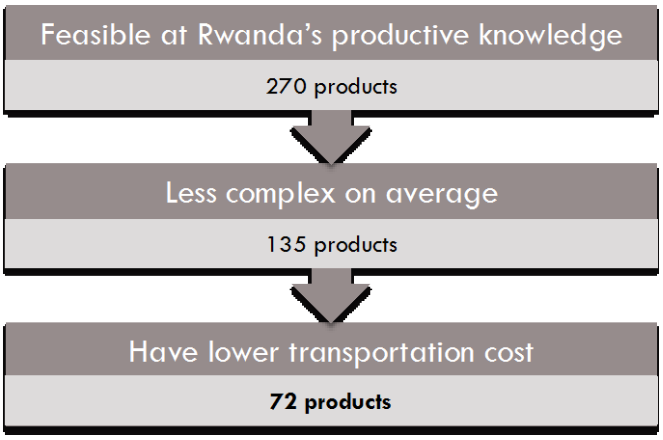
Source: COMTRADE data, own calculations.

Opportunities in Global Markets

To identify products that represent promising opportunities for global markets we start with the 270 products identified as feasible as described in Section 5. From this group we first consider those products that are less complex than average, consistent with the strategy that will focus on less complex products for global exports, which leaves 135 products.

Among this group we next identify products with lower transportation costs. While it is difficult to ascertain transportation costs for different products, Yildirim et al. (forthcoming) develop a methodology that provides an estimate of transportation cost by product using the United Nations SITC4 level data.[12] Using their estimates we classify each product as having low, medium, medium-high, or high transportation costs. Figure 16 illustrates the estimates of average transportation cost by industry. In order to identify strategic products for global markets we consider only those products with below average transportation costs. This yields a final list of 72 candidate products that represent opportunities for Rwanda to diversify its exports to global markets.

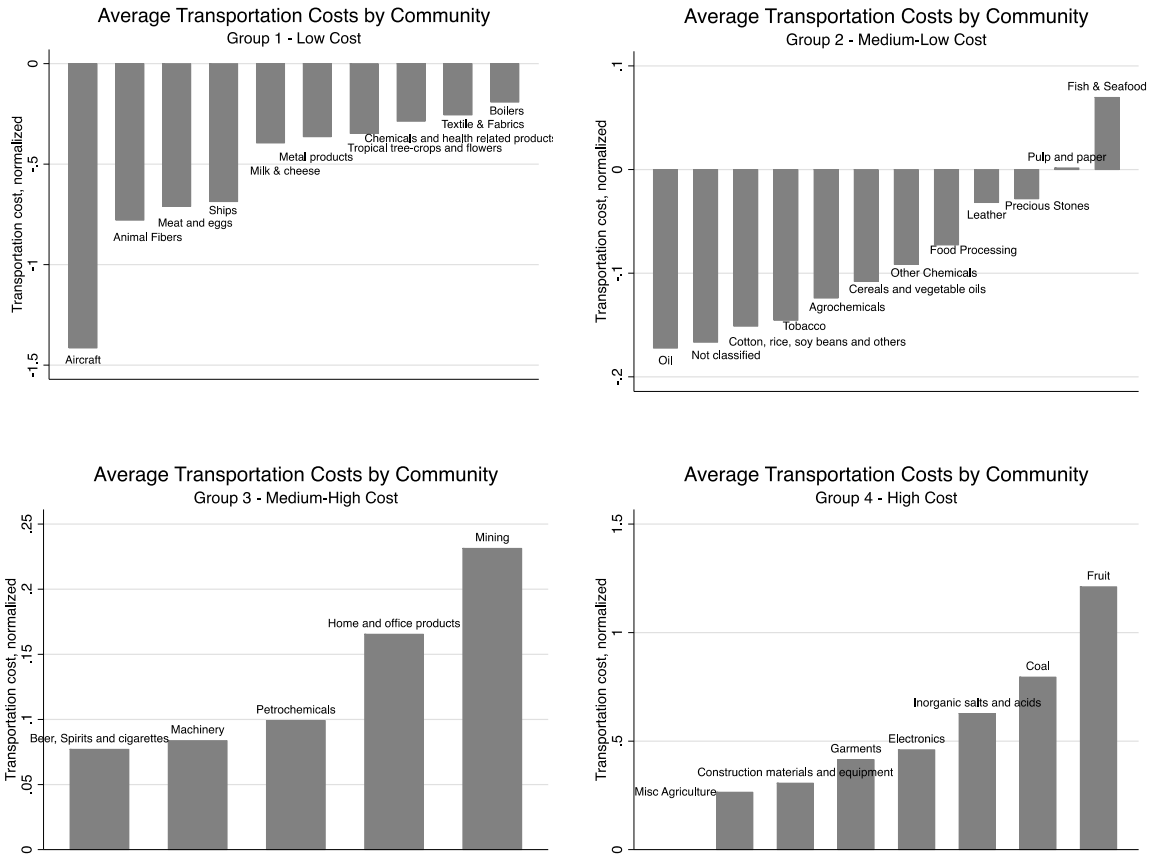
Figure 15: Identifying Strategic Products for Global Markets



The results highlight three main areas with greatest potential for Rwanda to develop its global exports: 1) Processed agricultural products, foods, beverages and agrochemicals 2) Specialized textiles and garments, and 3) Construction materials, metal and wood products.

[12] The authors identify the most dependable reporters of trade data, adjust for data irregularities, and control for cost factors such as shipment distance to arrive at an average difference between CIF and FOB values by product, which provides an estimate of average transportation cost by product.

Figure 16: Transport Costs by Product Community (estimate)



Source: Authors' calculations based on Yildirim et al. (forthcoming).

The first major group, **Processed agricultural products**, foods, beverages and agrochemicals, includes variety of products that use local agricultural output but transform it into products of higher complexity that are made less perishable and thus can be shipped for export. Examples of products in this groups include coffee extracts, sugars, syrups, and fermented beverages, various vegetable oils, preserved fruits and jellies, concentrated and preserved milk and cheese products, live poultry and eggs, preserved meats, as well as herbicides, pesticides, and fertilizers. The 30 frontier products in this category account for more than US$ 145 billion of world trade and have seen high growth rates in the last decade.

The second group, **Specialized Textiles and Garments**, includes silk, lace, yarn, synthetic fibers, carpets, rugs, matts as well as footwear, of which Rwanda already exports some US$ 100k in value. These items do not require fast market access and can rely on local inputs. The 12 frontier products in this category account for more than $100 billion of world trade, with moderate growth rates.

The third major group, **Construction materials, Metal and Wood products**, also makes use of local inputs– and includes items like iron bars, wood railway parts,

electric wire, wood pulp, and lightly processed metals. It also includes electric current, which Rwanda already exports in low quantities. The 14 frontier products in this category account for more than $200 billion of world trade, with very high growth rates.

In addition the strategy identifies a number of miscellaneous products including jewelry, candles, hand tools, and other decorations. Reassuringly, we find a good degree of overlap between the identified products and the non-traditional priority export sectors that were identified in Rwanda's National Export Strategy (2011) although the criteria and methodologies used to identify sectors were different.[13] In particular, both strategies highlight opportunities in horticulture (with a focus on processed foods), home décor and fashion (crafts, textiles, silk, jewelry), and dairy.

[13] The national export strategy built on analytical work undertaken by the OTF Group in 2009 which analyzed in depth more than 50 potential export sectors and applied scores from 1-5 based on evaluators' judgment on how they performed on criteria of potential export contribution, job creation, number of existing firms, market attractiveness, existing skill base, opportunity for diversification, and investor prospects. Source: *Rwanda National Export Strategy* (2011).

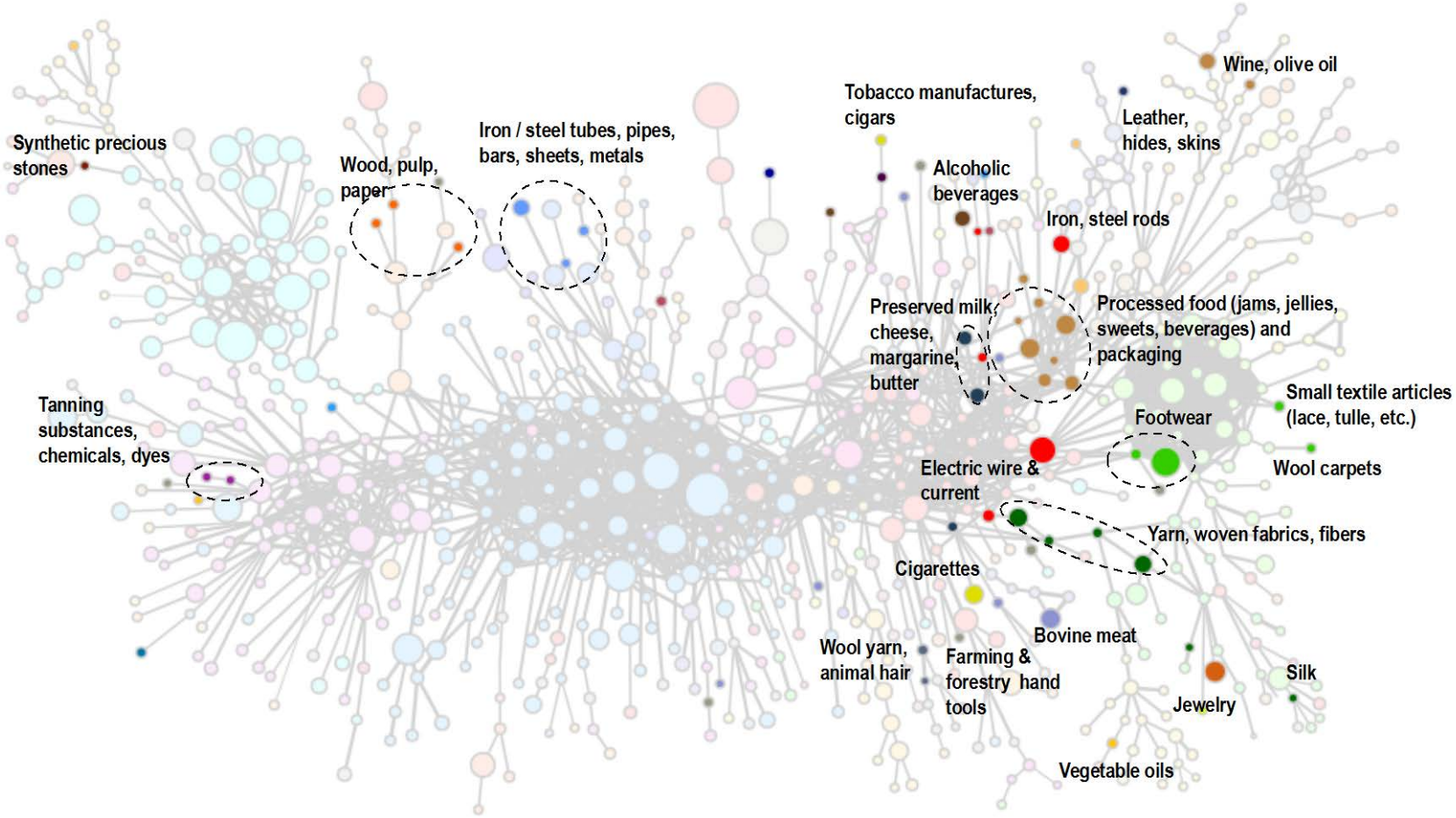
Table 3: Summary Statistics of Products Selected for Exports to the World

Community	Frontier products	Current RCA	Distance (norm.)	PCI	Opp. Gain (norm.)	Transport costs (norm.)	Global growth (2000-2010, per annum)	Rwanda, current exports (US$)*	World trade (US$ million)*	Region imports (US$ million)*`	Region exports (US$ million)*
1. Processed Agricultural Products, Foodstuffs, Beverages, Agrochemicals											
Food Processing	9	0.01	0.72	-0.31	0.31	-0.34	16%	34,248	145,000	216	104
Meat and eggs	6	0.02	0.74	-0.33	0.38	-0.95	12%	2,980	33,500	7	3
Milk & cheese	3	0.00	0.72	-0.14	0.40	-0.95	13%	-	40,100	14	9
Animal Fibers	2	0.00	0.74	-0.46	0.29	-0.90	0%	-	3,490	0	0
Beer, Spirits and Beverages	2	0.00	0.73	-0.44	0.34	-0.11	11%	92	21,900	25	4
Cereals and vegetable oils	2	0.03	0.75	-0.37	0.36	-0.53	9%	1,273	1,800	8	3
Tobacco	2	0.00	0.69	-0.52	0.26	-1.01	11%	-	20,500	19	56
Agrochemicals	2	0.13	0.78	-0.10	0.47	-0.70	13%	16,480	5,440	14	2
Misc Agriculture	1	0.00	0.75	-0.56	0.30	-0.46	10%	-	235	0	0
Tropical tree-crops	1	0.00	0.73	-0.66	0.34	-0.76	44%	-	2,240	4	0
2. Textiles, Garments, Footwear											
Textiles & Fabrics	7	0.00	0.79	-0.31	0.33	-0.58	2%	-	36,400	71	1
Garments	5	0.02	0.75	-0.44	0.29	-0.29	5%	101,401	90,100	107	18
3. Construction Materials, Metal and Wood Products											
Construction materials	5	0.16	0.77	-0.31	0.40	-0.29	13%	322,637	128,000	185	17
Metal products	3	0.00	0.78	-0.21	0.41	-0.30	27%	-	32,900	67	10
Mining	3	0.09	0.70	-0.51	0.29	-0.57	22%	138,724	78,800	2	38
Pulp and paper	3	0.00	0.75	-0.19	0.36	-0.35	16%	-	7,880	1	0
Other											
Chemicals & health	2	0.00	0.72	-0.27	0.38	-0.14	12%	-	2,000	4	6
Inorganic salts	2	0.00	0.73	-0.35	0.38	-0.74	23%	-	16,200	17	2
Machinery	2	0.00	0.75	-0.18	0.50	-0.83	16%	-	2,860	24	0
Aircraft	1	0.00	0.79	0.00	0.42	-0.34	9%	-	3,610	91	0
Precious Stones	1	0.00	0.84	-0.02	0.52	-0.08	4%	-	600	0	0
Ships	1	0.00	0.71	-0.53	0.24	-0.29	38%	-	21,600	12	0
Not classified	6	0.15	0.75	-0.28	0.43	-0.90	5%	14,820	12,200	36	1
Total / Average	**71**	**0.04**	**0.75**	**-0.32**	**0.36**	**-0.56**	**12%**	**632,655**	**708,000**	**923**	**276**

Note: Complete list of identified products is available from authors upon request.

* In each case, value represents volumes in only the selected frontier products, and not of the community overall.

Figure 17: Products identified for exports to the world in the Product Space

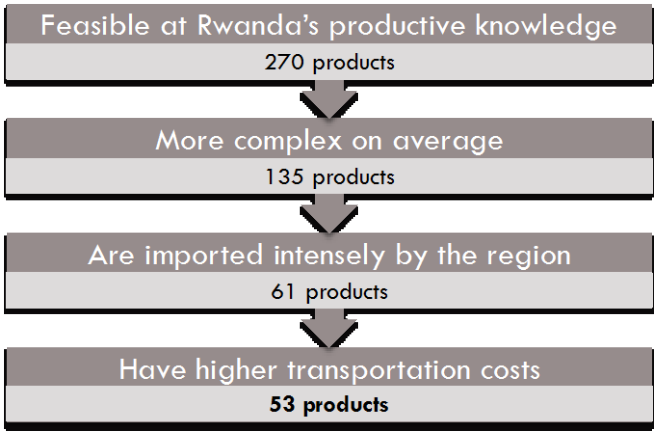


Source: Authors' calculations based on UN COMTRADE data. Exports data at the SITC4 level. For color legend, refer to Footnote 11. Size of node corresponds to total world trade in the product.

Opportunities in Regional Markets

Newt we ask: What products offer promising opportunities to expand Rwanda's exports to its region? The regional market (Burundi, the Democratic Republic of the Congo, Kenya, Tanzania and Uganda) represents more than US $85 billion of GDP, close to US $20 billion of annual imports and a population of more than 120 million (as of 2009). This market has more than doubled its volume of imports during the 2000s and is likely to continue to grow in the future due to investments in the resource and construction sectors but also due to rising regional incomes which will fuel demand for consumer goods.

Figure 18: Identifying Strategic Products for Regional Markets



To identify what Rwanda is in a good position to supply to the region we leverage the strategy developed in Sections 2 and 5. We focus on those products that are more complex on average and that the region imports intensively. To measure import intensity, we calculate a measure of import RCA and only consider the products for which the region is a net importer with import RCA greater than one.[14] These filters identify 61 different products that represent promising opportunities for diversifying Rwanda's exports to the region. Finally, to allow Rwanda to compete on transportation costs we remove those with the lowest transportation cost, which yields a final list of 53 products. The results yield a list of strategic products that fall in three, partly different, clusters: 1) **Machinery and Electronics, 2) Construction Materials, Metal and Wood products**, and 3) **Chemical products**. Table 4 shows the summary statistics and Figure 19 shows the breakdown of regional imports of these products by category and by destination.

The largest share of products identified as strategically important for the regional market fall in the **Machinery and electrical products** categories, which are some of the most sophisticated categories in the product space. However, the strategy identifies the products within these categories that are closest to Rwanda and in which it may have an opportunity to compete given the right investments. These include the simpler agricultural work and food processing machinery and parts (tractors, dairy machinery,

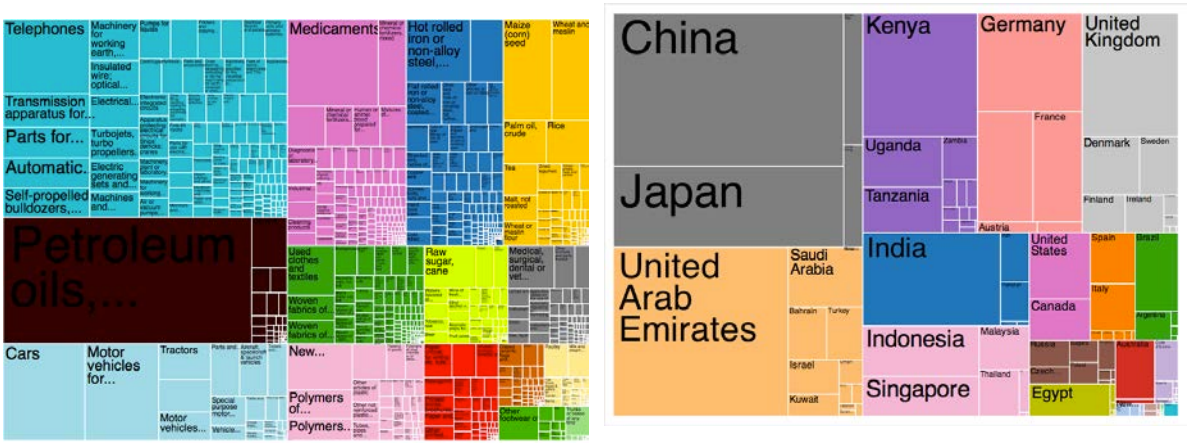
[14] In parallel with the notion of export RCA, we define import RCA as the ratio between the share of a product in the imports of the region and the share of that product in the imports of the world, where the imports of the region are defined as the sum of the imports of Burundi, the DRC, Kenya, Tanzania, and Uganda.

conveyor belts). The 17 frontier products in this category account for US$888 million of regional imports and only US$38 million of exports from the region.

The next largest categories of regional imports are products related to **Construction materials** including builders' carpentry, containers, reservoirs, articles of paper and stationery as well as a also identified a separate cluster of paper and paper / printed products. The 14 frontier products in this category have relatively high transportation costs compared to other goods. The region imports close to $700 million of these goods, and exports roughly US$ 100 million.

Finally, the **Chemical products** cluster features medicaments, certain plastics and polymers, and chemical substances (dyes, acids, salts) ad well as a cluster of agrochemicals (fungicides, herbicides, pesticides, fertilizers). The regional imports of the 14 frontier products on this category amount to US$ 1.2 billion wile exports from the region are only US$ 86 million, representing a *large opportunity for any regional producer who can competitively supply these products*.

Figure 19: Imports of Rwanda's neighbors in Selected Products (left). Origins of Regional Imports (right)



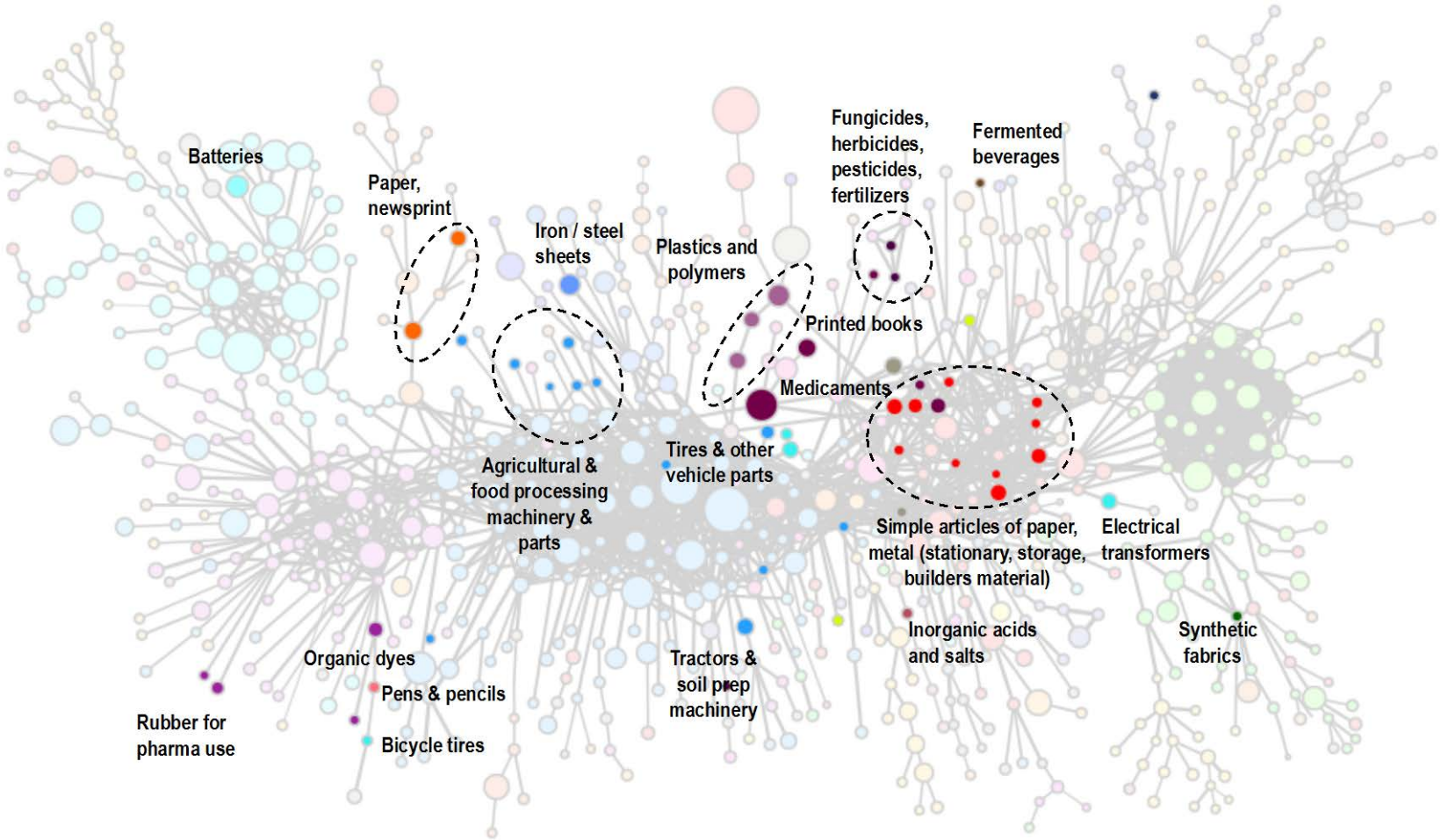
Source: Authors' calculations based on data at the HS4 level (CEPII).

Table 4: Summary Statistics of Products Selected for Exports to the Region

Community	Frontier products	Current RCA	Distance (norm.)	PCI	Opp. Gain (norm.)	Transport costs (norm.)	Global growth (2000-2010, per annum)	Rwanda, current exports (US$)*	World trade (US$ million)*	Region imports (US$ million)*	Region exports (US$ million)*
1. Machinery and Electronics											
Machinery	12	0.00	0.82	0.63	0.62	0.30	14%	4,158	75,500	550	25
Boilers	4	0.10	0.82	0.33	0.52	0.02	20%	112,423	48,100	248	6
Electronics	1	0.04	0.83	0.49	0.47	-0.28	12%	17,467	30,800	90	7
2. Construction Materials, Metal and Wood Products											
Construction materials	10	0.08	0.79	0.42	0.52	0.20	14%	190,174	114,000	436	36
Pulp and paper	2	0.00	0.79	0.39	0.50	0.28	2%	-	17,400	126	22
Home and office	1	0.00	0.78	0.23	0.51	-0.30	5%	1	5,450	12	5
Metal products	1	0.10	0.79	0.29	0.47	0.12	16%	50,450	36,500	124	42
3. Chemical products											
Other Chemicals	5	0.01	0.78	0.49	0.56	0.13	14%	96,304	301,000	626	72
Chemicals and health	4	0.00	0.83	0.58	0.63	0.10	7%	525	19,400	56	1
Petrochemicals	3	0.00	0.82	0.32	0.51	-0.05	17%	7,970	93,200	528	10
Agrochemicals	2	0.37	0.72	0.48	0.55	0.33	14%	24,009	8,970	50	3
Other											
Misc Agriculture	2	0.00	0.76	0.16	0.46	-0.19	18%	803	12,400	52	5
Not classified	2	0.00	0.81	0.57	0.61	0.28	14%	541	26,200	97	14
Beer, Spirits an	1	0.37	0.78	0.25	0.47	-0.24	16%	4,586	883	5	4
Inorganic salts	1	0.00	0.78	0.19	0.48	0.62	14%	-	6,770	29	2
Textile & Fabric	1	0.00	0.81	0.10	0.47	0.33	3%	-	2,740	9	0
Total / Average	**52**	**0.05**	**0.80**	**0.45**	**0.55**	**0.16**	**13%**	**509,411**	**799,000**	**3,040**	**252**

Note: Complete list of identified products is available from authors upon request.
* In each case, value represents volumes in only the selected frontier products, and not of the community overall.

Figure 20: Products identified for exports to the region in the Product Space

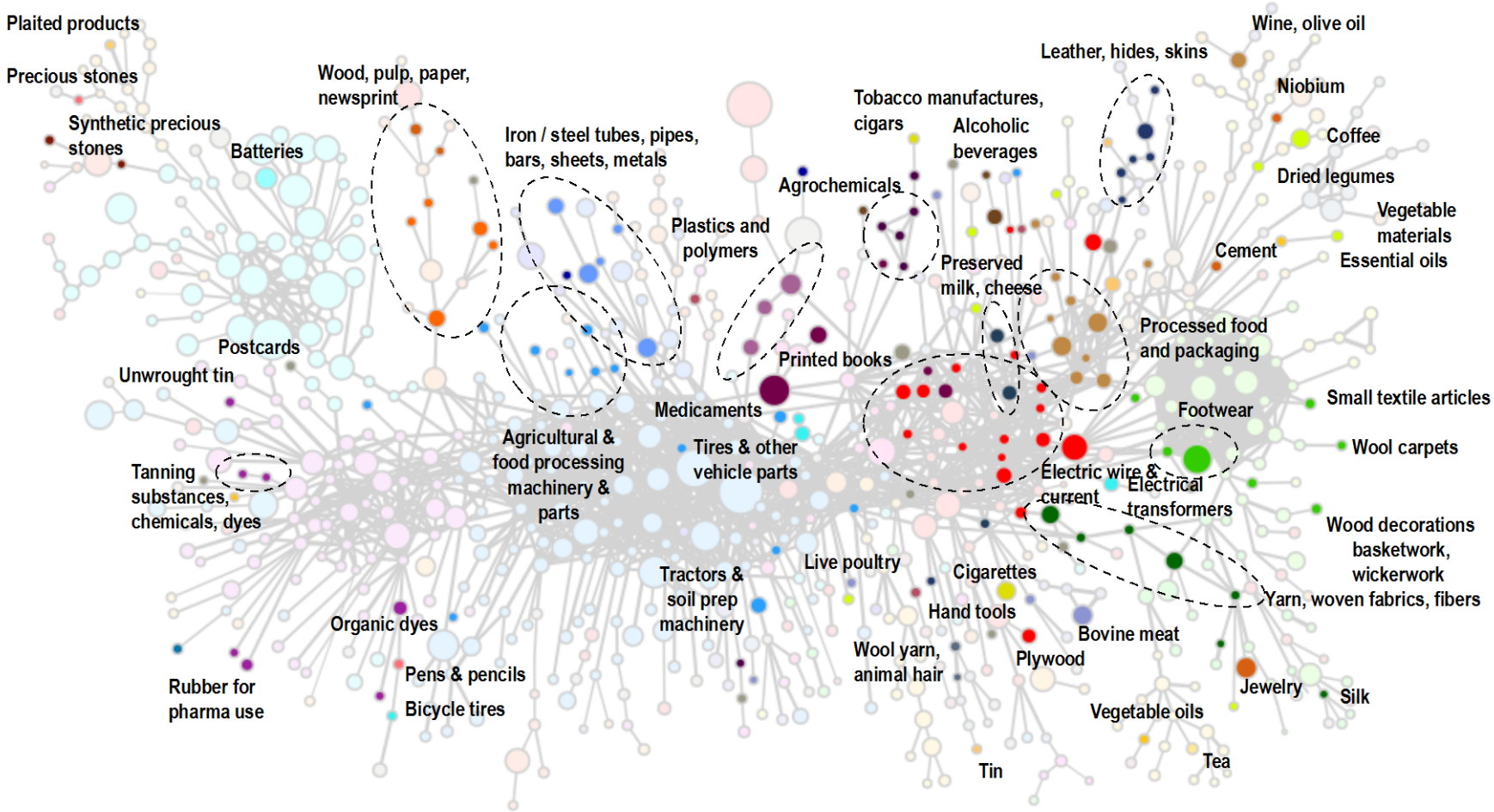


Source: Authors' calculations based on UN COMTRADE data. Exports data at the SITC4 level. For color legend, refer to Footnote 11.

Putting the pieces together – Rwanda's current exports and the potential new exports to global markets and regional markets – Figure 21 presents a vision of Rwanda's future product space. Compared to Figure 10 which showed Rwanda's product space today, this figure is not only more populated but it features several clusters, or *groupings of related products* rather than scattered appearances. This is consistent with the key insight of the product space, which is that countries diversify by leveraging knowledge, resources, and capabilities that they already posses to move into *related* activities. The result is a future product space where Rwanda has established itself as a competitive exporter in a number of communities including processed foods, simple construction and home materials, fabrics and fibers, footwear, agrochemicals, pulp and paper, and simple agricultural and food processing machinery and parts.

While the vision is relatively ambitious in some respects, global data provides evidence that countries have tended to successfully increase the diversity of their exports by populating the product space, moving from the simpler products in the right side to the more complex products in the left side. The current strategy envisions Rwanda consolidating and growing its initial presence in some of the emerging industries in the less complex parts of the product space (textiles, processed food, construction and home materials) while also beginning to push the boundary of its productive knowledge by moving towards the nearest products in the more distant and sophisticated communities in the center and left halves of the product space (machinery, chemicals, metal- and paper-based products). Given their greater distance from Rwanda's current productive knowledge the development of these products would likely require greater coordination and investment. However the externalities generated by these investments would continue to spill over and facilitate the future development and diversification of Rwanda's economy.

Figure 21: A Vision of Rwanda's Future Product Space



Source: Authors' calculations based on UN COMTRADE data. Exports data at the SITC4 level. For color legend, refer to Footnote 11.

7. Policy Implications

We have mapped the most promising pathways for the growth and diversification of goods exports in Rwanda, identifying activities that are best positioned to take advantage of Rwanda's strengths while circumventing the key constraints. The identified activities consist mostly of agro-processing and light manufacturing (garments, construction materials, simple machinery and parts). While the approach that we used was sensitive to the constraints of land, infrastructure, and productive capabilities, still these emerging industries will need to find ways to lessen the effect of these constraints and operate profitably in Rwanda. Here we discuss polices that can support the development and growth of such activities and aid Rwanda in making the transition to a more manufacturing-oriented, urbanized economy.

1) Special Economic Zones

Special Economic Zones (SEZs) are an excellent policy instrument in Rwanda because they have the potential to jointly and cost-effectively address the critical constraints identified. SEZs provide access to industrial land, which could otherwise be costly and time-intensive to acquire. Second, they provide access to quality infrastructure (electricity, transport, communications infrastructure, security) and do so faster than would otherwise be possible if the country had to invest in infrastructure across many different locations. Finally SEZs build capabilities by agglomerating related activities so that they can benefit from learning externalities. The Government of Rwanda has made SEZ development an important part of its economic policy and the first SEZ in Rwanda, the Kigali Special Economic Zone recently begun operating. Development of the second phase is currently underway.

Attracting greater private investment in SEZ development should be a top priority. Now that initial efforts of the Government of Rwanda and its PPP have demonstrated that there is sufficient demand among businesses for SEZ plots, the time is ripe to prioritize making the next SEZ project a privately developed one. The private SEZ model has the benefit of requiring fewer government resources and, in many cases, private SEZs have proven more successful than government owned and operated SEZs (World Bank, 2008). Under the private SEZ model the government transfers or leases land to a developer who invests in the infrastructure and services of the SEZ. Since these resources provide benefits to all SEZ tenants, the private developer succeeds in internalizing the coordination externalities that typically plague the provision of public goods and common pool resources and is able to charge rents to recover their investment.

In addition to lessening financial requirements on the government, private developers are in an excellent position to gauge the needs and demands of business for specialized services. Private SEZs in the Dominican Republic provided a range of higher-end services to their tenants and were able to charge as much as a three-times premium on the rents (World Bank, 2008). Associations of private SEZ developers can also become an organized voice that communicates with government to address needs and

gaps as they arise. Such a relationship between private SEZ developers and government proved effective in the Dominican Republic, which developed more than 30 private zones.

While outsourcing as much of the development and operating functions to the private sector as possible, they Government can focus its capacity on ensuring that it provides ongoing support in addressing operating problems as they arise. For example, the cost of transporting workers to and from SEZs can be an important constraint in low-income countries such as Rwanda. Currently, no public transport operates between the Kigali SEZ and the city. This type of problem can best be addressed in cooperation. An important role for the government in continuing SEZ operation is to have the capabilities in place to provide solutions to similar problems encountered by the users and operators in the SEZ as they arise. This will require the government to both have a direct communication link to the SEZ (e.g. via an on-site presence) as well as the capacity to coordinate other government agencies to deliver inputs as required. The Government of Rwanda has set up the Special Economic Zones Authority of Rwanda for this purpose. It is important to ensure that the agency has sufficient capacity to address problems that are likely increasingly likely to arise as the first SEZ now has begun operating and usage is growing.

2) Investments in Critical Infrastructure Outside of SEZs

While they will relieve some important constraints, investments in SEZs alone will still not address the high cost of transporting goods to and from regional and international ports. Rwanda is currently undertaking investments in rail, joint with Kenya, Uganda, and South Sudan, which will connect it better to its region. This should reduce the costs for a good number of goods, especially those that can be profitably shipped by rail, for example processed metal articles and some bulk agricultural products.

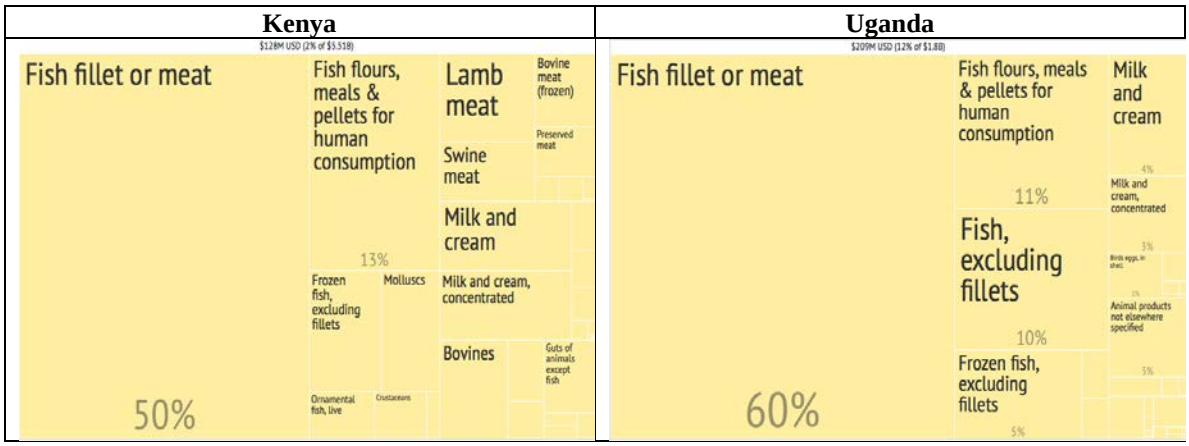
Other goods that we are recommending, for example processed cheese, meats, milk, eggs, will require more sophisticated logistics, such as a cold chain. Here Rwanda can leverage the experience of its neighbors. As Figure 22 shows, Kenya currently exports more than $100 million of animal products and Uganda more than $200 million. The Government of Rwanda can learn form their experience or find ways to share usage of some of the existing regional logistics chains.

In addition, air transport can be used for some types of goods. While the cost of export of, for example flowers is very high, once a country invests in an air-based flower supply chain costs decrease. Rwanda is one of a handful of countries in the world whose geography (high elevation but equatorial climate) provides good conditions for the growth of flowers and a number of countries with similar conditions (e.g. Columbia, Ecuador, Kenya, Ethiopia) have found it attractive to invest heavily in their flower export infrastructure. Once the infrastructure exists, other products can leverage it.[15] Especially for goods that are covered by favorable trade agreements, such as agro processing and

[15] Export shipments by air accounted for 32 percent of the value of all U.S. exports, albeit in the U.S tend to be high value per ton goods, notably high-value electronics, manufacturers, chemicals, and machinery.

textiles (e.g. under AGOA), even with higher transport expenses Rwanda may be able to be a competitive exporter.

Figure 22: Exports of Animal Products in Kenya (left) and Uganda (right), 2010



Source: Atlas of Economic Complexity.

3) Facilitating rural-to-urban migration

As Rwanda creates new employment opportunities in manufacturing, the new activities will draw population away from subsistence activities in the countryside and into light manufacturing activities in urban areas. Thus, in tandem with an industrial transformation we also envision a spatial and demographic shift occurring in Rwanda, with urbanization continuing to climb, population growth moderating, and development occurring in growing semi-urban and urban areas. As population is drawn from the countryside to cities to supply the human capital that will be demanded by the newly developing industries, existing urban infrastructures will be stressed. Currently Kigali is the only major urban center in Rwanda. The city needs to devise a vision and plan for a future in which is may experience extremely high growth rates, such as those seen by a number of cities in transitioning countries (for example in China, Turkey). The government will need to think creatively and address problems of housing, utilities provision, security and the provision of other public services such as heath and education.

4) Improvements in agricultural productivity

Rwanda has the 10th lowest agricultural value added per worker in the world but its levels of productivity are ahead of Burundi, Uganda DRC and not far from Tanzania and Kenya, who have significantly better developed agricultural export activities. Part of the low productivity is due to the high agricultural density and small land plots – the demographic transition we describe above will naturally relieve some of that density. Another is that the current production is mostly consumed locally, where demand is less sophisticated and mostly concentrated in basic goods, like cassava and plantain.

The strategy that we propose identified processed agricultural products and foodstuffs as a key area of potential export development. In order for this to be viable, and for Rwandan farms to become a stable source of input supply for a local processing industry, productivity in rural areas will need to rise. To this effect, the government should continue to prioritize programs that enhance the productivity.

Given small land plots and disbursed production, Rwanda could benefit from the model of aggregators, or "food-hubs" which has been making inroads in other markets (e.g. the United States). Aggregators exist in order to link up small farmers to larger-scale buyers of agricultural produce. Aggregators are being used in the U.S. mostly to enable larger-scale buyers such as restaurants, specialized retailers, or schools to source input from multiple suppliers. However the same model could be applied to supply inputs to an agro-processing industry in Rwanda. In addition to marketing and distribution, aggregators can offer many other value-added services, such as fertilizer distribution, marketing, quality assurance, and packaging. They can also help farmers with production planning so that they can better meet buyers' needs.

Summary

Rwanda has delivered very robust performance during its rebuilding phase over the past two decades. The Government of Rwanda is working hard to sustain that growth and expand on the economic opportunities for all Rwandans. In this strategy we have stressed the importance of developing a larger and more diversified manufacturing and exporting footprint, one which in addition with the development of service activities, will begin to transform Rwanda from an agricultural subsistence economy to a modern-day economy. While we have carefully considered the constraints that Rwanda faces, we are also very optimistic about the opportunities for light manufacturing in Rwanda. If it continues to maintain a stable political and social environment, continues to prioritize critical investments in supporting infrastructure and regional and global trade integration, we believe that Rwanda can not only maintain but even accelerate its growth and continue to be a model of good development practice for countries in its region and beyond.

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