Final report

The economic geography of Rwanda

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Laterite is a data, research and advisory firm based in Rwanda, Ethiopia, India, Uganda, Kenya and the Netherlands (www.laterite.com). Laterite specializes in innovative data collection and analysis techniques that help answer critical development questions.

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Abbreviations

B2B	Business to business
B2C	Business to consumer
EBM	Electronic Billing Machine
EICV	Integrated Household Living Conditions Survey (Rwanda)
IGC	International Growth Centre
LED	Local Economic Development
LODA	Local Administrative Entities Development Agency (Rwanda)
MININFR	Ministry of Infrastructure (Rwanda)
NISR	National Institute of Statistics Rwanda
SDC	Sales Data Controller
WB	World Bank

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Executive Summary

This study, funded by the International Growth Center and supported by the Ministry of Infrastructure of Rwanda and the Rwanda Revenue Authority, aims to generate new insights to support spatial and urban planning in Rwanda.

This study is about better understanding the reality of economic geography and urbanization in Rwanda, with a particular focus on cities. The report provides policy makers with new information about the economic geography of Rwanda and news ways of looking at geographic trends. It puts Rwanda's into context. The analysis we present focuses on better understanding:

(i) Urbanization and population density patterns in Rwanda;
(ii) The geography of firms in the country;
(iii) Structural transformation at the city-level and the implications thereof; as well as
(iv) Internal trade between Rwandan cities.

In this study we use an original mix of data sources including a unique dataset of all VAT transactions in 2017 to understand the trade of goods between formal firms across the country. We also rely on the newly published Rwanda Establishment Census (from 2017), EICV 5 (2016-2017), the Labour Force Survey (2017), the Population and Housing Census from 2002 and 2012, and publicly available population density data to understand changes in economic activities and human settlement patterns across the country.

We summarize some of the key messages from the analysis and articulate policy implications:

Population growth in secondary cities: an opportunity and a challenge that needs careful planning

This study confirms that Rwanda is urbanizing quickly, with high population growth rates in both Kigali and secondary cities. Secondary cities that were experiencing the fastest population growth rates between 2012 and 2015 included Rubavu (5.5% per year), Musanze (4.1% per year), and smaller towns such as Byumba and Nyagatare (more than 10% per year). Evidence from the EICV 5 datasets reveals that people are moving to cities in order to gain employment or to seek further education. It seems to be "pull factors" that are attracting internal migrants away from rural areas and towards cities. The immediate surroundings of secondary cities are also densely populated, suggesting that they will gradually be integrated into the city ecosystem, generating greater scale and opportunities for growth.

An important trend to be aware of is that it is people in the wealthiest population quintile (as per EICV 5) that are currently migrating from rural to urban areas. This has several important implications. First, current trends contribute to creating greater spatial imbalances. These growing spatial imbalances are evident from a number of findings in this report, including for example the low integration into the economy of rural areas. Second, this indicates that there is a barrier to the migration of the poorest. One possibility is that the cost of relocation or the cost of living in the city is

simply too high for people in the poorest quintiles. Third, the poorest migrants are currently re-locating to other rural areas, but this will not always be the case. Push factors, including the loss of land, the loss of employment and the lack of opportunities, is what is driving the migration of the poorest. As land becomes scarcer and competition for farm-jobs as labourers increases, these migrants will look for new opportunities in cities. This will be even further pressure on low cost housing and job creation. It is important for policy makers to start thinking ahead, about what greater migration of much poorer households in the future might imply for urban development policies.

The study also shows that population growth tends to precede firm creation and structural transformation. It seems to be the case that people move first, then firm creation and structural transformation follows. Further research could investigate whether this sizeable population inflow is fully absorbed by a growing workforce; if this was not the case, urban unemployment or high levels of underemployment would become a key policy challenge. Similarly, future work could also assess whether there are bottle-necks in the provision of urban infrastructure that generate negative urbanization externalities, hampering the economic and social benefits of the urbanization process.

Prioritize resources between secondary cities - Rubavu has the highest potential

This study shows that secondary cities are not equivalent in their size or potential for future growth. There is a lot of variation in the demographic and economic footprint of secondary cities. Given limited resources, spatial development policies should take these differences into account in the allocation of funding and the selection of priorities for the spatial development of the country.

Based on this study, Rubavu - across multiple metrics - appears to be the city with the highest potential for growth. Rubavu has by far the largest population of Rwanda's secondary cities and has sustained amongst the highest population growth rates. It also has the greatest number of firms among secondary cities and has been experiencing comparatively high firm creation rates. Its economy is converging faster than any other towards Kigali city, moving away from an agriculture-based economy towards other economic activities. It is poised to grow further. On firm creation, structural transformation and internal trade flows, Rubavu is lagging behind its population. We have shown that in the Rwandan context, population growth can precede economic growth, suggesting that Rubavu has a high "catch-up" potential. Furthermore, it is located in a strategic cross-border location by Goma, it is next to Rwanda's second largest secondary city, Musanze, and has by far the highest road connectivity of any other secondary city. Its economic center, Gisenyi Sector, is a very vibrant economic center.

Manage key spatial imbalances: invest in connecting Nyamasheke District to the economy

We observe the biggest disconnect between population levels and trade predictions in Nyamasheke District. Despite having comparatively high population levels and being located on a strategic highway along the Kivu Belt, Nyamasheke is disconnected from Rwanda's EBM economy. It is a District with very low urbanization rates and no significant towns. The inner country of Nyamasheke has amongst the lowest road connectivity levels in the country. Nyamasheke does not have an asphalted road connection to the west of the country, connecting it to Nyanza or Muhanga for example. Providing

Nyamasheke with the connectivity it needs can yield high trade benefits and lead to a more accelerated levels of urbanization in the District.

Think beyond the boundaries of specific cities - local connectivity and high-density population belts

Population patterns suggest it is important to think beyond the boundaries of specific cities, or administrative areas such as provinces and districts. **This is important for two reasons. First Rwanda is urbanizing not only in and around cities, but also along broad axes connecting cities.** Policy makers might also consider the introduction of new administrative units that match more closely the functional urban agglomerations, so that policy fragmentation is minimized, and decisions are taken at the right spatial level. In particular, we identify four main urbanization axes: (i) the area in and around the capital, Kigali City; (ii) the north-western corridor of the country between Rubavu, Rwanda's second city in terms of population, and Musanze, an area we refer to as the "Virunga belt"; (iii) the Kigali, Muhanga to Huye corridor, along Rwanda's main highway, which we refer to as the "Southern belt"; and (iv) the "Lake Kivu belt" – from Rubavu, through to Karongi and Rusizi. While the Eastern Province remains comparatively less dense, it is quickly picking up. The Eastern Province has experienced the highest population growth rates since 2002.

The second reason it is important to think beyond city boundaries, is because evidence suggests that cities have an influence over a much larger territory than the immediate city boundaries. One of the key messages of this study is that Rwanda's economy is very concentrated in the capital and in small little urban Sectors within secondary cities, near the city-center.The potential of a city is not only determined by the population levels within its boundaries, or right in the city-center, but also by the population in its surrounding areas. Importantly, growing urban centers can also have a poverty-alleviating effect on the rural population nearby. The cities with the greatest potential from that perspective are Musanze, which had more than 500,000 people living within 15km of the City in 2012; Rubavu with a population of about 373,000 in its vicinity in 2012; Huye with a population of 364,000; and Muhanga with 344,000. Deepening the local connectivity of the economies of these cities to this large population pool is strategically important (see for example Cali and Menon on the effects of urban spill-overs on poverty reduction in neighbouring rural communities, 2009) [1].

Infrastructure matters

We have shown in this study that road infrastructure matters and that it potentially has a large effect on trade. From a policy prospective, it is important to understand whether improved transport infrastructures would have a "centrifugal" effect, i.e., would result in the decentralization of economic activities away from the Capital, or rather would have a "centripetal" effect, i.e., economic activities would further concentrate in Kigali. The centrifugal forces will prevail for activities for which input costs are lower in smaller cities, as improved transportation infrastructure would make easier to serve the larger final market in Kigali. The centripetal effect would instead dominate for those high value-added activities for which urbanization externalities and agglomeration benefits are particularly important, like e.g. advanced services and the knowledge-based economy.

[1] Calì, M., & Menon, C. (2013). Does Urbanization Affect Rural Poverty? Evidence from Indian Districts. The World Bank economic review, 27(2), 171-201

One issue that we were not able to directly address, but that is central to connecting Rwanda's economy, is the cost of mobility. Better infrastructure is not sufficient to generate the intended growth effects; people and firms need to be able to afford the costs of transport.

Risks associated with place-based sector specialization policies

Rwanda's city branding strategy needs to be managed with care and to be combined with other non-sector specific policies. We find that there is overlap between the brand names proposed for Rwanda's secondary cities and the areas in which these cities have a revealed comparative advantage. However, having a revealed comparative advantage in a given activity within the Rwandan context, does not necessarily imply that secondary cities will have the required capabilities to sustain growth in that sector. We have shown, using a smart specialization model, that promoting a place-based policy targeting greater specialization in specific economic sectors of activity can be a high-risk strategy for secondary cities. It would in some cases entail creating sectors from scratch or starting from a low base. This does not mean that a sector-focused approach would fail, but it does mean that a sector-specialization policy would involve risks, with a high probability of failure, but also high rewards if the policy succeeds. Given the high risks we recommend that sector-specialization policies not be the core pillar of any spatial development or city development strategy, but rather one of several pillars.

Another important lesson from the discussion on smart specialization is that different types of economic development strategies might be required for different types of regions. Secondary cities really have the option between two types of sector strategies: (i) either a high risk approach, with a high risk of failure, but high returns if it succeeds; or (ii) a "slow road" policy, starting with less complex activities that are more achievable and gradually upgrading the firm-level capabilities of the city. This policy would have lower returns in the short term, but a higher likelihood of success.

Branches play a very important role

The analysis also reveals that branches are playing a very important role in transforming the economic geography and the economic development of Rwanda. Branches are the fastest growing group of firms. Branches introduce products and services to locations that were not available previously. They weigh heavily on local economies, especially in locations close to national borders. In the city of Rubavu for example, branches contributed to almost 40% of total sales; in Huye, branches contributed to 35% of sales; in Nyamata about 30% of sales; in Byumba and Rusizi about 26% of sales. We also show that branches are not only important locally, but also for cross-border transactions. There is a high concentration of branches in areas of the country that are close to national borders. The branches of Rwandan banks, supermarkets and accommodation providers in cities that are close to a border do not only service Rwandan customers, but also individuals and companies located on the opposite side of the border. We recommend that policy makers look into options to facilitate the growth of Rwanda's branch economy.

1. Introduction

The economic geography of Rwanda is characterized by relatively low levels of urbanization (estimated at about 18.5% in 2016-2017 according to EICV 5 data), a high urbanization growth rate, high population density and the urban dominance of Kigali City, the capital.

Rwanda has urbanized rapidly over the past decade and will continue to experience further urban growth in the near future. Urbanization in Rwanda has been driven by two key forces: internal migration from rural areas towards cities and population growth in the vicinity of urban areas, where high population density areas have been gradually integrated into the urban fabric of the country. Achieving higher levels of urbanization is also a strategic objective of the Government of Rwanda and a key component of its strategy to reach middle income status. Rwanda's Economic Development and Poverty Reduction Strategy (EDPRS II 2013-2018) and the National Strategy for Transformation and Prosperity (NSTP 2017-2024) identify sustainable urbanization as a key driver of economic growth.[2]

Urbanization in Rwanda has been dominated by Kigali City, the capital and "primary" city of Rwanda. Kigali accounts for almost 60% of the urban population (Population and Housing Census, 2012) and continues to experience very rapid population and economic growth. The rapid transformation of Kigali over the past decade is visible to the naked eye. The boundaries of the city have expanded, entire new neighbourhoods have appeared, and the city has modernized and upgraded its infrastructure and transportation systems.

Other secondary cities around the country - such as Rubavu, Musanze, Muhanga, Nyagatare, Rusizi and Huye - have also experienced a recent transformation. Their population levels are increasing, firm creation has been accelerating and new businesses and services have appeared. This change is visible in the city centers, where new branches of banks, insurance companies, supermarket chains and petrol service providers - amongst others - have started operations.

The Government of Rwanda has been actively developing policy responses to manage the urbanization process and the changing economic geography of the country. There is a broad recognition that the urbanization needs to be well managed in order to achieve its intended goals, including becoming a key driver of economic growth, improving living standards and quality of life within cities and achieving a greater geographic integration of the Rwandan economy.[3] The Government of Rwanda has made it a priority "pro-actively managing the urbanisation process and mitigate risks of urban sprawl, divided cities, high urban unemployment and high urban poverty.[4]

One of the key policies of the Government of Rwanda with respect to urbanization is to promote the development of alternative centers of economic growth. These alternative centers of economic growth, aimed at attracting migrants looking for work and better living conditions, include six selected

[2] Republic of Rwanda, Ministry of Finance & Economic Planning, *EDPRS II*, 2013, pp 13; Republic of Rwanda, *DRAFT National Strategy for Transformation and Prosperity*, 2017, pp 7

[3]See Republic of Rwanda, Ministry of Infrastructure, *National Urbanization Strategy*, 2015, pp 36

[4]Republic of Rwanda, Ministry of Finance & Economic Planning, *EDPRS II*, 2013, pp 13

secondary cities, located across the country: Rubavu, Musanze, Rusizi, Muhanga, Huye and Nyagatare.[5] The hope is that government-led promotion of economic activities in these cities can help correct regional imbalances and offer a larger proportion of the rural population access to off-farm employment.[6] Each secondary city, according to the National Roadmap for Green Secondary City Development and the National Urbanization Policy, also has a brand attached to it with the aim of promoting targeted investments in selected economic activities and clusters**.** These include[7]:

Table 1: City branding in the National Urbanization Strategy and the National Roadmap for Green Secondary City Development

Secondary City	National Urbanization Strategy	National Roadmap for Green Secondary City Development
Huye	Education, Knowledge and Cultural History	Knowledge, Culture and Agribusiness
Muhanga	Hydropower and Mining Centre ; Creative Economy ; Pottery and Fashion	Logistics and Trade Platform for Rwanda
Nyagatare	Cattle and Dairy Region/ Commercial Hub of Eastern Region	Commercial Hub of the East and the Dairy Centre
Rubavu	International Gateway City and Tourism	Lakeside hub for Tourism and Industry
Musanze	Eco Friendly Mountain Tourism and Industry	Eco-Tourism City
Rusizi	Cross-Border Trade and Transportation Logistics, Nyungwe Forest	Western gateway for Tourism and Trade

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This study is about better understanding the reality of economic geography and urbanization in Rwanda, with a particular focus on cities. Using a variety of new and unique data sources, combined with an interesting set of analytic techniques, the analysis we present focuses on better understanding:

(i) Urbanization and population density patterns in Rwanda;
(ii) The geography of firms in the country;
(iii) Structural transformation at the city-level and the implications thereof; as well as
(iv) Internal trade between Rwandan cities.

[5] Republic of Rwanda, Ministry of Finance & Economic Planning, *EDPRS II*, 2013, xv

[6] Republic of Rwanda, Ministry of Finance & Economic Planning, *EDPRS II*, 2013, pp 36

[7] See Republic of Rwanda, Ministry of Infrastructure, *National Roadmap for Green Secondary City Development*, 2015, pp 38 and pp 193; see Republic of Rwanda, Ministry of Infrastructure, *National Urbanization Policy 2015,* pp 38

While this study is not unique in its exploration of secondary cities in Rwanda, it is unique in terms of the mix of data and techniques it uses. The study produces a lot of new knowledge about Rwanda's economic geography. We study population density and population growth patterns and learn some new facts about the composition of internal migration to Kigali and secondary cities in Rwanda. We study firms through the lens of the Establishment Census and EBM data, which enables us to draw lessons about the latent potential of cities and about the importance of Rwanda's branch economy. Using complexity analysis and the smart specialization framework we learn more about structural transformation in Rwanda and the capabilities of cities. Finally, for the very first time we are able to map internal sales flows between pairs of firms and cities, by using item Electronic Billing Machine (EBM) tax data. We apply a population gravity model to predict export flows between cities and discuss its implications.

We conclude by emphasising some of the opportunities and risks associated with urbanization in the Rwandan context, including the importance of prioritizing investments in cities with the highest potential, better managing spatial integration and integrating disconnected Districts, the benefits of thinking and strategizing beyond the boundaries of cities, the transformative role of branches in the Rwandan economy and finally the strategic implications of a placed-based sector specialization policy.

Structure of the report

The report consists of the following sections:

- **Chapter two** will briefly outline the data sources that were used in this study;
- **Chapter three** will provide an analysis of population density, rates of urbanization and migration across Rwanda;
- **Chapter four** will provide an overview of the geography of firms, with a focus on changing trends in firm growth, firm location and firm density;
- **Chapter five** will focus on the structural transformation, drawing heavily from the complexity literature;
- **Chapter six** will present the economic geography of regional trade in Rwanda and the implications thereof for spatial policy; finally,
- **Chapter seven** will conclude on policy relevant insights from each of the preceding chapters.

2. Overview of the data

In this study we use an original mix of data sources including a unique dataset of all VAT transactions in 2017 to understand the trade of goods between formal firms across the country. We also rely on the newly published Rwanda Establishment Census (from 2017), EICV 5 (2016-2017), the Labour Force Survey (2017), the Population and Housing Census from 2002 and 2012, and publicly available population density data to understand changes in economic activities and human settlement patterns across the country.

Electronic Billing Machine data

In 2013, Rwanda mandated the use of Electronic Billing Machines (EBM) for all VAT-registered businesses, which includes all business with an annual turnover exceeding Rwf 20m (around $22,500). For every transaction (business to business transactions or business to consumer) a VAT-registered business makes, it must provide the customer with an EBM receipt and this data is transmitted to the Rwanda Revenue Authority (RRA) database. Certain industries are VAT exempt or zero rated and are not included in the EBM receipts database.[8] The main exclusions are exports, agricultural products, transport services, medical and health services, basic education, financial and insurance services, and ICT and mobile services.

Approximately 14,213 EBM machines are held by 12,068 firms across the country (2017 data). Laterite obtained an anonymised dataset of all receipts issued in 2017, with the assistance of IGC, in order to conduct its analysis. The data includes all transactions that took place in the year 2017. The data that was received in the dataset from the RRA included: (i) the seller's (anonymized) TIN, (ii) the buyer's (anonymized) TIN, (iii) the amount of the product sale (receipt level), (iv) the SDC code (Machine number) and (v) receipt level sales information. Laterite also obtained an anonymized version of the TIN registry and an anonymized version of the SDC registry from RRA. Laterite used EBM data and SDC data to identify the location he origin of sales and destination of sales across the country. Most analysis included in this report use sales at the receipt level to measure sales.

To study the link between economic geography and the firm-to-firm network, we make an assumption about the branch structure of firms. Firms can have multiple EBM machines, each tied to the same TIN number. When firms have EBM machines in different geographic Sectors, we can make a very reasonable assumption that these EBM machines belong to a branch of the firm located in a different part of the country. However, there are several cases of firms with multiple EBM machines in the same geographic Sector. In this situation we are not able to distinguish whether all these machines belong to one or multiple firm-locations within that Sector. For example, supermarkets could have all their counters linked to one EBM machine, or they could simply have multiple EBM machines. There is nothing preventing a company from having multiple EBM machines in the same

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Articles 5 and 6 of LAW N°37/2012 OF 09/11/2012 ESTABLISHING THE VALUE ADDED TAX

location. A firm might choose to have multiple EBM machines, just in case one fails. For the purposes of this study we make the assumption that all EBM machines within the same geographic Sector correspond to only one firm-location. It is a reasonable assumption to make, as there are few examples of firms in Rwanda with multiple branches within the same geographic Sector; however there are some cases that we will overlook, in particular in the highest firm-density areas, such as Nyarugenge Sector in Kigali. In the firm-to-firm network we study in this section, we consider each branch to be a separate economic actor.

In this firm-to-firm network, we also have to make assumptions about the location of buyers. We have very good information on the location of the seller/supplier, as each receipt is linked to a particular EBM machine, and we know where that machine is located. That is not true however in the case of the buyer. We know the TIN number of the buyer, and we know the location of the EBM machines the buyer has (if any), but if a firm has multiple branches, we do not know precisely which branch made the purchase. We decide on the location of the branch that made the purchase using the following logic: (i) if a firm has an EBM machine in the same geographic Sector as the supplier, then we assign the transaction to that firm-location; (ii) if this is not the case, then if the buyer has an EBM machine in the same District as the supplier, we assign the transaction to the firm-location in that District with the highest purchases; (iii) if the firm does not have an EBM machine in that District and only has one EBM machine, we assign the location of that EBM machine; and finally (iv) in all the remaining cases we assign the location of the firm at registration. While this assumption will inevitably lead to some misclassifications we believe it provides a reasonable working assumption that gives priority to transactions that are geographically close – which is also what the data very clearly shows.

Census data, WorldPOP data and POPGRID data

To estimate population levels we use data from the 2002 and 2012 Population and Housing Census data, for which large samples are publicly available online. We combine this information with high-resolution population density predictions from 2015 satellite data. The predictions were produced by the Center for International Science Information, at the Earth Institute of Columbia University, and the Connectivity Lab at Facebook. We can use this data to estimate population levels by location in 2015 at a very disaggregate level. More information can be found about the underlying methods used to make these predictions can be found on the website of the Center for International Science Information: http://www.ciesin.columbia.edu/data/hrsl/.

Establishment Census

The Establishment Census is a census of all formal and informal establishments in the country. The establishment census is conducted by NISR once every four years. The first Establishment Census was conducted in 2014 while the second was released more recently in 2017. The purpose of the Establishment Census is to capture firm related information, including but not limited to, the firm's (i) economic activity, (ii) number of employees, (iv) whether the establishment is a headquarter or branch, and (iii) a firm's annual turnover. The census captures geographic locations of each firm – down to the geographic sector level – while also capturing whether the establishment is formal or informal.

Laterite used the publicly available version of the Establishment Census 2014 to undertake some analysis related to firm density. Laterite also obtained a version of the Establishment Census 2017 with establishment location at the district level, and formal/informal status. However, the lack of geographic precision with the 2017 dataset meant that our analysis is limited.

We also make assumptions on the Establishment Census 2017 with regard to the classification of branches to micro, small, medium and large companies (at the aggregate level). In the 2017 Census data is not available on the number of employees in branches; employee figures are only captured at the headquarter level. This data was available however in the 2014 Census. We make assumptions on what proportion of branches in the 2017 Census are micro, small, medium or large using patterns from the 2014 Census at the District and urban levels. Branches are a very important structural component of the economic geography of Rwanda, so it is important we include them in this analysis. In this report we use the term "firms" to signify any private sector establishment – excluding cooperatives and associations - with 4 employees or more (whether formal or informal).

EICV 5

In this study we make use of the new Integrated Household Livelihood Survey (EICV 5), a national household survey that is representative at the District level and for which data collection happened in 2016-2017. The EICV series is repeated every 3 years. Here we use it for population estimates and to understand the dynamics of internal migration from rural to urban areas.

Labour Force Survey

The Labour Force Survey is a new survey conducted by NISR on a semi-annual basis (every 6 months). The survey, which was piloted in February 2016, has been conducted four times: in August 2016, February 2017, August 2017 and February 2018. Laterite requested for the use of the August 2016 and February 2017 surveys.

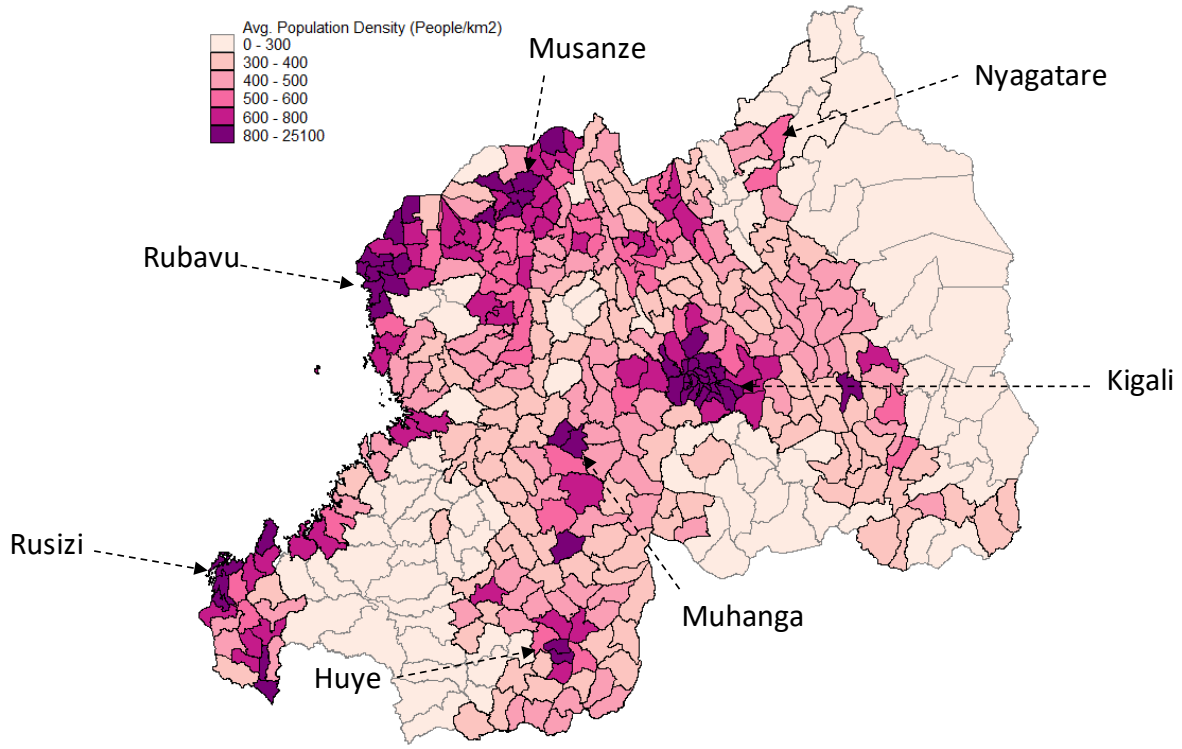
While the Labour Force Survey includes 4-digit ISIC codes and ISCO codes for the country's labour force, the sample size of the study, which were 9,344 for each survey, did not give us enough geographical precision of sample size to better understand economic activity at the district, and urban/rural level.

3. Urbanization in Rwanda and population density patterns

3.1 Population density

Rwanda remains a country with relatively low urbanization rates (estimated at about 18.5% in 2016-2017 according to EICV 5); however, the urban base of the country is expanding rapidly, largely around existing urban areas – including Kigali and the six secondary cities.

Figure 1: Population density by Sector (2012 Census data)

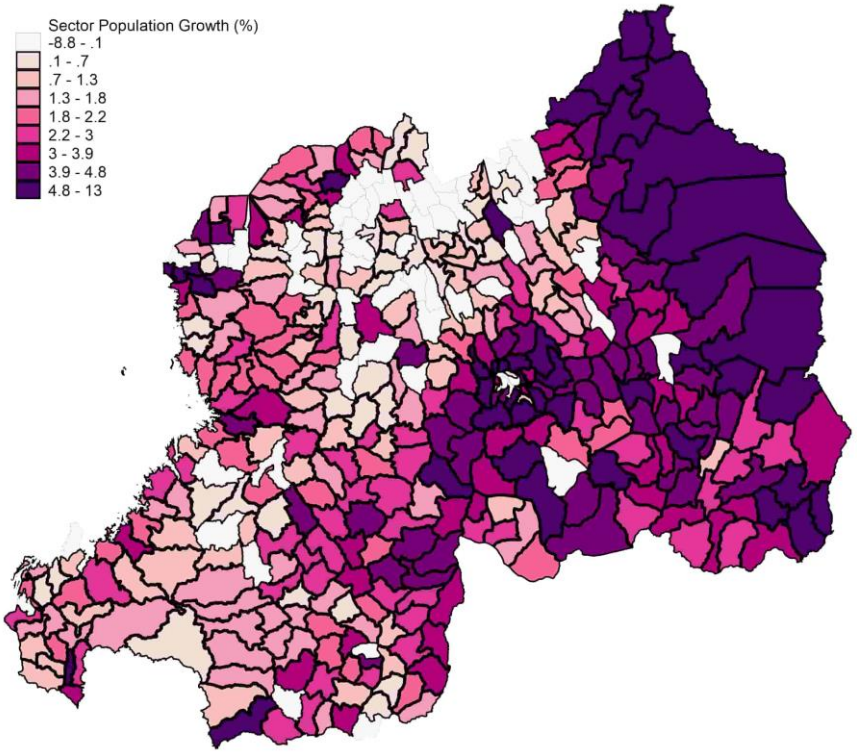


A map of population density in Rwanda reveals four high population density spots: (i) the area in and around the capital, Kigali City; (ii) the north-western corridor of the country between Rubavu, Rwanda's second city in terms of population, and Musanze, an area we refer to as the "Virunga belt"; (iii) the Kigali, Muhanga to Huye corridor, along highway 1, which we refer to as the "Southern belt"; and (iv) the "Lake Kivu belt" – from Rubavu, through to Karongi and Rusizi. The Eastern Province has lower population density levels on average, except in the proximity of emerging towns such as Rwamagana, Kayonza, Nyagatare and Nyamata. It is important to think of urbanization in the context of the broader demographic and economic landscape of the country.

The population of Rwanda is growing faster in the Eastern half of the country than the Western half of the country. These population growth patterns, observed during the 2002-2012 period (see figure 2), appear to have been sustained since 2012 (see figure 3). We estimate population migration

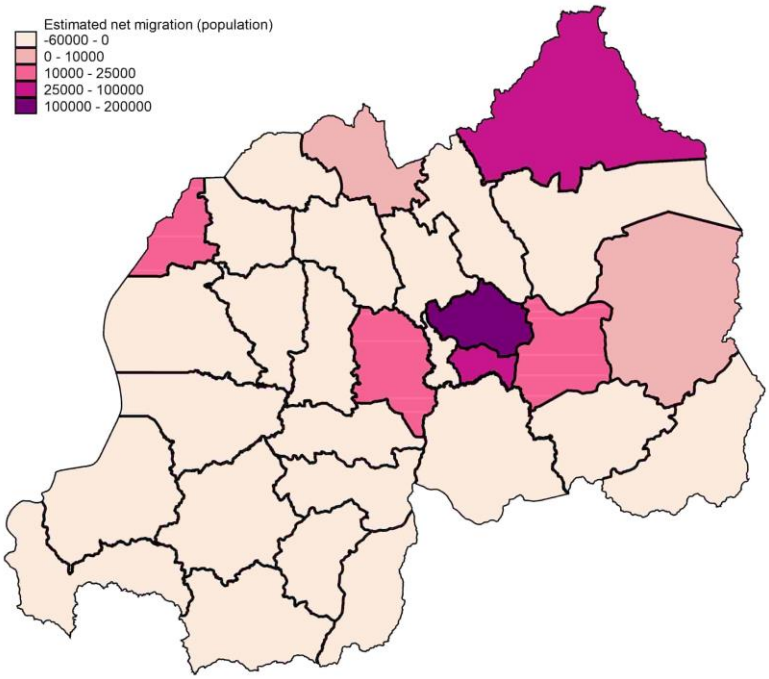
patterns between 2012 and 2016/2017 using EICV 5 data and LFS data. During the 2012-2017 period we observe positive net migration trends in several Eastern Districts and mostly negative net migration in the West. [9] This has important implications for the future of secondary cities. Cities in the Centre/East of the country – including Kigali, Nyagatare, Nyamata, Byumba, Rwamagana and Kayonza – are poised to benefit from the effects of more rapid population densification in and around urban areas.

Figure 2: Estimates – population growth at the Sector level 2002-2012 (using Census data)



[9]To estimate growth rates in urban areas since 2012, we use the EICV 5 survey (2016-2017) and the Labour Force Survey (2017). Both surveys asks respondents since when and how long they have lived in their current location and where they lived before moving to their current location. This enables us to estimate net migration into urban areas between 2012 and 2016-2017, assuming a natural population growth rate of 2.4%.

Figure 3: Estimates – population growth at the District level 2012-2017 (using EICV data)



3.2 The case of Kigali

The City of Kigali has grown twice as fast as the rest of the country. Between 2002 and 2012 - years for which Census data is available – the population of Sectors in the Province of Kigali grew by 55% on average, corresponding to a compounded annual growth rate of 4.5%. Sectors within 5km to 15km from the city centre, experienced the fastest population growth of about 5.9% compounded per annum. This compares a compounded annual growth rate of 2.4% for the rest of the country. In 2012, the City of Kigali represented about 58.5% of Rwanda's urban population.

Growth in population has been uneven throughout the Province of Kigali. Areas closest to the centre of the city, such as Nyarugenge, Muhima and Gikondo, lost population during the 2002-2012 period and have increasingly specialized in commercial/industrial activities (see

Figure 4 and Figure 5). Residential areas further away from the city centre, including Gisozi, Gatenga, Kinyinya, Kanyinya, Gahanga, Bumbogo and Gahanga have grown fastest. Figure 5 shows the effect of the expansion of the city, with the highest growth rates experienced in proximity of the city boundaries.

Figure 4: Population growth in Kigali's sectors between 2002 and 2012 by distance to the city centre

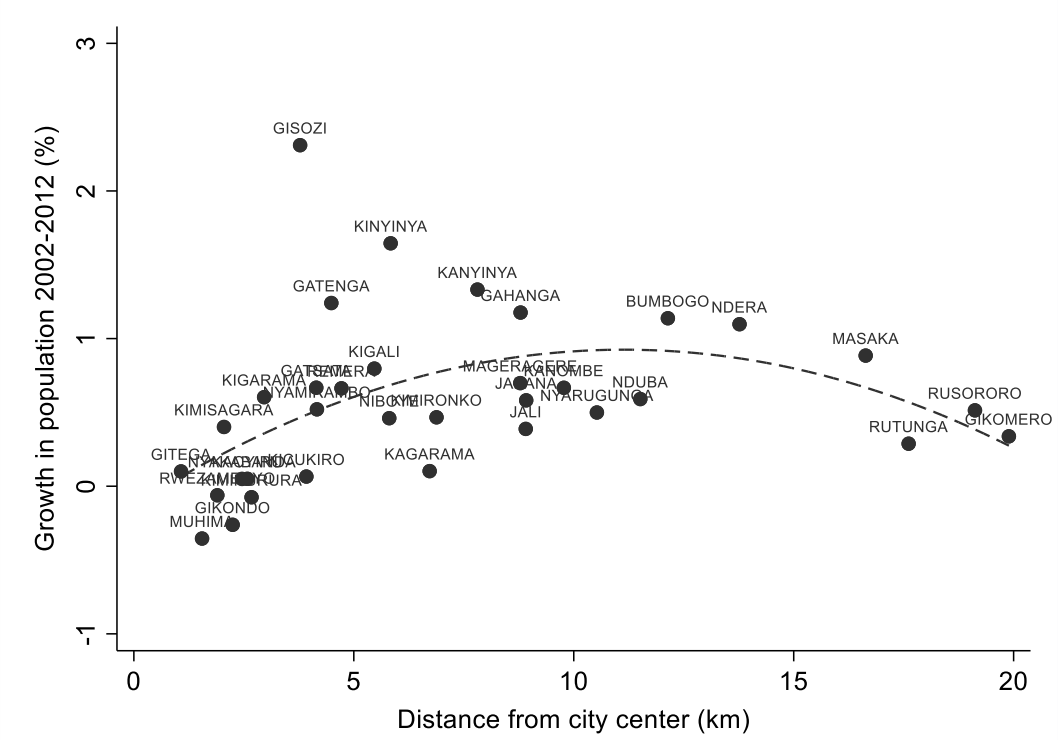
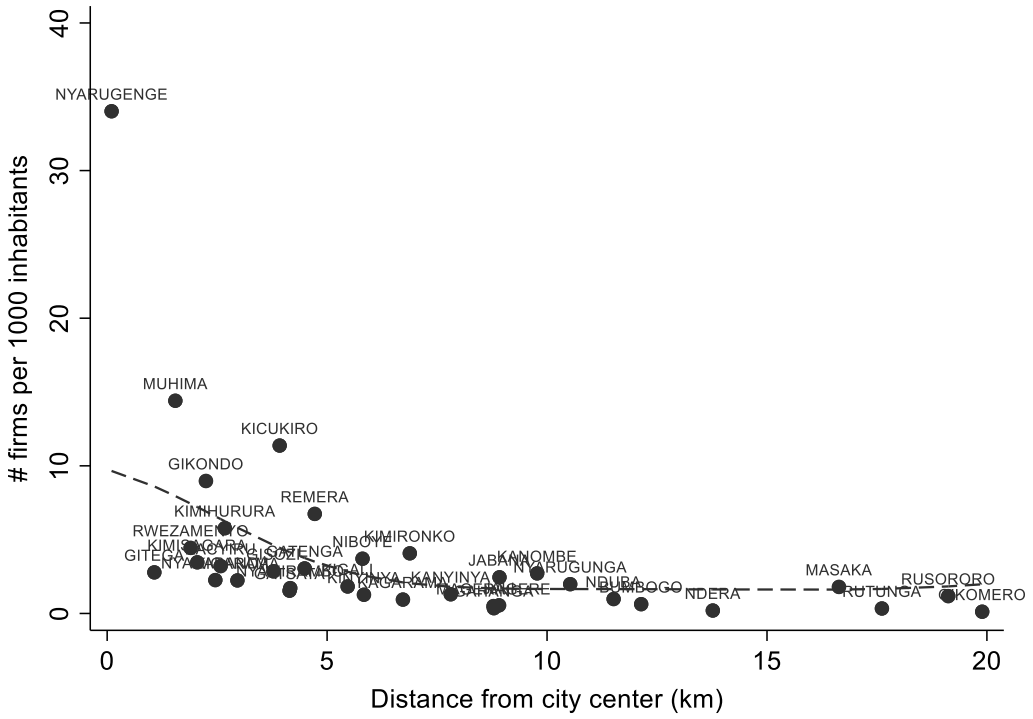


Figure 5: Number of private sector establishments with four or more employees per 1000 inhabitants, in Kigali between 2002 and 2012, by Sector and distance to the city centre



Kigali continues to attract migrants from mostly rural areas of the country and continues to grow faster than the population average. To estimate recent population growth rates in Kigali Province, we compare several different recent estimates of the population of Kigali Province to data from the 2012 Housing and Population Census. First, we estimate the population of Kigali Province by extrapolating from the weights of surveys that are representative at the District level, including EICV 5 (2016-2017) and LFS (2017). Second, we use high resolution population predictions from satellite data produced by the Center for International Science Information, at the Earth Institute of Columbia University, and the Connectivity Lab at Facebook to estimate population levels by location in 2015[10]. Third we calculate expected population growth rates given observed migration patterns using EICV 5 and LFS (2017) data. Both surveys ask respondents when they last moved and where they lived before moving to their current location. This enables us to estimate net migration by District between 2012 and 2016-2017 and to estimate population growth, assuming a natural population growth rate of 2.4%. The estimates we obtain are presented in Table 2. All estimates show that between 2012 and today, population growth in Kigali has continued to be significantly higher than in the rest of the country. There is however a lot of variation in the estimated population growth rates for Kigali Province over the past few years, ranging from 3.7% to 8.3% compounded per annum. This puts our estimates of the population of Kigali Province in 2017 at anywhere between 1,340,000 and 1,650,000, compared to about 1,119,000 in 2012. Note that Kigali Province also includes rural areas. According to EICV 5 an estimated 73.8% of the population of Kigali lived in urban areas. Therefore we estimate the population of the City of Kigali to be between 990,000 and 1,230,000 people in 2017, compared to about 846,000 at the time of the 2012 population Census.

[10] More information on the methods used and the data can be found on the website of the Center for International Science Information, at the Earth Institute of Columbia University (http://www.ciesin.columbia.edu/data/hrsl/)

Table 2:Compounded annual population growth predictions for Kigali Province - comparison of methods

Locaton	EICV 5 weights (2012-2017)	LFS weights (2012-2017)	CEISN-Facebook HRSL satellite predictions, (2012-2015)[11]	EICV 5 migration patterns (2012-2017)[12]	LFS migration patterns (2012-2017)
Kigali Province	7.82%	8.28%	5.33%	4.90%	3.70%
Rest of country	2.07%	1.32%	3.54%	2.6%	2.40%

Kigali is Rwanda's "primary" or "primate" city. It accounts for a larger proportion of the urban population than the capitals of its East African neighbours, but is very much in line with other smaller African nations such as Congo Brazaville for example (see table 3). Urban primacy is typically defined as the share of the largest metro area in the national urban population[13]. Having a high level of urban primacy is part of the development process, in particular in small countries. Countries need a metropolis that connects them to the world. Vernon Henderson finds that for every level of economic development there is an optimal level of urban primacy; this optimal level of urban primacy increases up to a national GDP per capita income level of about US$3000, before decreasing thereafter (Henderson, 2000)[14]. The literature on urban primary is mixed on the effects of high urban concentration on economic growth at the national level. Henderson (2003) argues that over-concentration, in particular in higher income countries, can have detrimental effects on economic growth. David Castells-Quintana argues that there are conditions under which urban primacy is associated with positive growth effects (when the quality of urban infrastructure and the access to basic services in the primary city is high), and conditions under which primacy is associated with negative growth effects (Castells-Quintana,2017).[15] While there is not sufficient evidence to conclude on the effects of urban primacy on GDP growth, the literature converges on the idea that urban primacy comes at the expense of spatial integration. In a recent paper, re-visiting evidence on urban primacy within the African context, Henderson and Kriticos demonstrate that urban primacy is high across Africa and that the urban hierarchy favours the largest city at the expense of the development of secondary cities, which are lagging in industrial development (Henderson and Kriticos, 2017)[16]. They show that there is a very high premium attached with living, working and operating out of the "primate city". Urban primacy in the African context has been associated with sprawl leading to cities that are

[11] Estimates based on Facebook-CIESIN's High Resolution Settlement Layer (HRSL) population predictions

[12] Own calculations using EICV 5 and LFS (2017) data

[13] Vernon Henderson, *The Urbanization Process and Economic Growth: The So-What Question*, Journal of Economic Growth Vol. 8, No. 1 (Mar., 2003), pp. 47-71

[14] Vernon Henderson, *The effects of urban concentration on economic growth,* NBER Working Paper Working Paper 7503, 2000

[15] David Castells-Quintana, *Malthus living in a slum: urban concentrations, infrastructure and economic growth,* Barcelona Research Institute of Applied Economics, Working Paper 2015/06

[16] Henderson, J. Vernon and Kriticos, Sebastian (2017*), The development of the African system of cities*, Annual Review of Economics. ISSN 1941-1383

crowded, disconnected and costly for both firms and households (Lall, Henderson and Venebles, 2017).[17]

Table 3: Primacy of capital city, international comparisons

Country	Year	Capital	Urban	Primacy of capital City (% of urban population)	Source
Uganda	2014	1,507,114	7,425,864	20.3%	Population Census
Kenya	2009	3134000	9328000	33.6%	Population Census
Tanzania	2012	4,364,541	12,701,238	34.4%	Population Census
Rwanda	2012	845,730	1,446,499	58.5%	Population Census
Congo Brazaville	2007	1,373,382	2,285,551	60.1%	Population Census

3.3 The case of secondary cities and emerging towns

Rwanda's six secondary cities - and other emerging towns in the country - are an order of magnitude smaller than Kigali. The population of Kigali in 2012 was about double the total population of the next largest ten cities in the country. To estimate the size of cities more recently, we rely on satellite predictions from the 2015 CEISN-Facebook HRSL population data; it is not possible to use alternative data sources to predict city level population levels - such as EICV or LFS - due to low statistical power. Using this data we estimate that Kigali's urban population in 2015 was slightly less than million inhabitants, compared to fewer than 200,000 inhabitants for the next largest city, Rubavu. In turn, Rubavu's population, was about 1.5 times larger than the next largest city, Musanze, with an estimated population in 2015 of about 114,000. Remaining secondary cities – including Huye, Muhanga, Rusizi and Nyagatare - were estimated to have between 47,000 and 76,000 inhabitants. The ensuing discussion on the economic geography of Rwanda and the economic potential of secondary cities needs to be put into the context of this reality. There is one large and dominant city, Kigali; there is one medium sized city, Rubavu; the remaining secondary cities and other emerging urban towns in the country are small.

Table 4: Actual population and project population of Rwanda's main cities

City	City type	Population 2012 (Census)[18]	Estimated population 2015 (CEISN-Facebook	Estimated population growth rate 2012-2015 (using POPGRID)

[17] Lall, Somik Vinay,J. Vernon Henderson, and Anthony J. Venables,*Africa's Cities: Opening Doors to the World.* World Bank, Washington, DC, 2017 License: Creative Commons Attribution CC BY 3.0

[18] These were obtained by estimating the urban population by district based as defined in the Census 2012.These figures differ from the World Bank figures highlighted in *Note 1: Urbanization and Evolution of Rwanda's Urban Landscape*, 2017, pp 17

			HRSL satellite predictions)[19]	
Kigali (urban)	Capital	845,727	941,573	3.6%
Rubavu	Secondary	148,939	174,865	5.5%
Musanze	Secondary	101,580	114,556	4.1%
Huye	Secondary	44,570	49,690	3.7%
Muhanga	Secondary	44,800	47,863	2.2%
Rwamagana-Kayonza	Emerging town	65,608	67354	0.9%
Byumba	Emerging town	22,300	30,405	10.9%
Rusizi	Secondary	60,229	61,625	0.8%
Nyagatare	Secondary	47,670	66,008	11.5%
Nyamata	Emerging town	28,299	27,984	-0.4%

Population growth estimates suggest that over the past five years the population of secondary cities have also been growing rapidly. On average, the population of secondary cities has grown at an estimated 4.6% during the 2012-2015 period. There is a lot of variation in the population growth rates of secondary cities. The fastest growing secondary city is also the smallest, Nyagatare, with an estimated population growth rate of 11.5%. Rubavu and Musanze appear to be expanding rapidly, with estimated growth rates above 4%. Rusizi, Muhanga and Huye are growing at a slower pace of between 0.8% and 3.7%. Population growth rates are a leading indicator of the economic attractiveness of cities.

Population density estimates in and around cities in Rwanda provide evidence of both densification and urban expansion. Cities are like magnets with a broad reach, attracting population over a large geographical span. We show this by studying the population density of Sectors (2012 Census) based on their distance to the nearest city. We calculate the distance between a Sector and the city centre using the centroid location of the Sector. Sectors are associated to the city that is closest to them. The analysis is imperfect, because sectors vary in size and shape - and because it is difficult to delineate precisely where a city starts and ends - but the comparison yields very clear patterns (see Table 4).

First, density is highest in and around the largest cities. Cities expand not only through geographical expansion, but through a process of densification. Population density in Sectors within 5km of the centre in Kigali is the highest in the country, with more than 6,000 people per square kilometre. The Sector with the highest population density in Rwanda in 2012 was Gitega in Nyarugenge District (Kigali), with a density of over 25,000 people per square kilometre. This shows that even within the centre of Kigali there is still a lot of scope for further densification. Population density levels in Rubavu, at around 2,000 per square kilometre in Sectors within 5km of the city centre, were almost three times lower on average than in Kigali. The same figure in the remaining secondary cities was about 1,500 people per square kilometre or lower.

[19] These were obtained by estimating the urban population in each district in which secondary cities and emerging cities were located. Urban areas were determined using NISR demarcations.

Second, population density decreases exponentially as we move away from the city centre, but continues to decrease over a relatively large geography area. Sectors that are further away from the city centre have lower levels of population density on average, but a higher level of population density than Sectors that are even further away. This holds true in all secondary cities, except the smallest – Nyagatare. Even small secondary cities such as Rusizi or Muhanga, with populations in the vicinity of 50,000 inhabitants, exert an influence over a geography radius of at least 10 km. The increasing densification of areas in the vicinity of cities is an indication of the potential presence of urban expansion.

Table 5: Population density of Sectors based on the distance of the Sector centroid to the city centre

Cities	Population density (pop/ km^2) of Sectors within radius (2012 Census data)			Total population within radius (2012 Census data)		
	<5km	5-10km	10-15km	<5km	5-10km	10-15km
Kigali	6,243	1,539	667	488,940	795,070	1,095,000
Rubavu	2,243	1,079	922	139,200	236,060	373,980
Musanze	1,470	677	560	109,560	241,510	511,840
Muhanga	1,264	504	469	83,070	197,780	343,880
Huye	1,307	630	420	50,370	212,910	364,420
Rusizi	1,041	682	508	74,860	166,940	237,380
Nyagatare	328	119	405	53,920	73,910	140,730
Byumba	643	495	488	52,140	186,070	341,640
Rwamagana	884	445	414	33,380	129,370	213,710
Kayonza	794	469	449	42,720	98,380	220,360
Nyamata	380	331	306	36,100	65,060	240,060
Total				**1,164,260**	**2,403,060**	**4,083,000**

The future economic potential of cities is not only determined by the size of their current population and the population density within the city boundaries, but also by the size of the population in surrounding areas. The zone of influence of cities extends beyond their current boundaries. Even though Rubavu currently has by far the largest population of secondary cities according to 2012 Census data, the size of the population living in Sectors that are within 10 km of the city is similar across Rubavu and Musanze, with Muhanga and Huye not too far behind (see Table 5). When we expand the zone of influence of secondary cities to a radius of 15km, Musanze clearly stands out as the secondary city with the largest zone of influence. In 2012, over 500,000 people lived in Sectors that were located within a 15km radius from the city. This compares to between 340,000 and 370,000 for cities such as Rubavu, Muhanga, Huye and Byumba and 250,000 or less for Rusizi, Nyagatare, Nyamata, Kayonza and Rwamagana.

3.4 Who is migrating to urban areas and why?

In this section we use EICV 5 data from 2016-2017 to identify who is migrating to cities and why. A common perception about urbanization in developing countries is that it is driven by poverty (see for

example Ravillon, Chen and Sangraula, 2007)[20]. It is driven by internal migrants who seek to escape poverty by moving to the city, but find themselves in a poverty-trap, disconnected from job markets and facing high living and mobility costs (see Lall, Henderson and Venables, 2017). [21] While there is ample of evidence of the link between poverty and migration, it has also been established that it is often not the poorest who migrate to cities, as migrating can be very resource-intensive (see Van Hear, 2012)[22].

In the Rwandan context it is not the poorest who migrate to cities, but the people in the wealthiest quintile, thereby driving a greater wedge between rural and urban areas. Focusing on the population of adults that migrated from rural areas in Rwanda (defined either as a small town or the country side) to a city (either a big city or the capital) in the year before the EICV 5 survey was conducted, we find that about 73% belonged to wealth quintile 1 and 13% to wealth quintile 2; only 4% of migrants who moved from more rural areas to cities belonged to the poorest quintile. We restrict the analysis to only people who migrated in the past year alone to limit the incidents of cases where people after moving experienced a rapid increase in their socio-economic status. We make the reasonable assumption that within 1 year of migrating it is unlikely that people's socio-economic status completely changed. The findings don't change however with different definitions of what migrant from rural to urban areas means or by changing the period of migration.

The poorest tend to migrate for push factors; the wealthiest for pull factors. EICV 5 asks respondents what the main reason of migration was. We divide the reasons provided into three groups: (i) pull factors, which involves moving for employment or to pursue studies; (ii) push factors, including moving because of the loss of employment, the lack of employment opportunities, the lack of land, inadequate access to public services or a disaster/conflict; and (iii) other factors, which mostly includes family related reasons (for example a parent having moved or other family reasons). Table 6 shows that 57% of internal migration of people in quintile 5 was driven by pull factors versus 11% for push factors; in comparison, 15% of migrants in quintile 1 listed pull factors as the main reason for migration, compared to 38% who listed push factors (in particular the loss of land, the loss of a job or the lack of employment opportunities). Note that in this table we do not look at the reason for internal migration from rural to urban areas, but any for any form of internal migration.

Table 6: Reasons for moving, by quintile, for adults who migrated in the past year (EICV 5)

Quintile	Pull factors	Push factors	Other	Total
Q1	14.8%	38.0%	47.2%	100.0%
Q2	17.0%	43.8%	39.2%	100.0%
Q3	19.2%	42.3%	38.5%	100.0%
Q4	35.7%	26.9%	37.4%	100.0%
Q5	57.1%	11.1%	31.8%	100.0%

[20] Martin Ravillon, Shaohua Chen and Prem Sangraula, "*The Urbanization of Global Poverty*", Development Research Group, World Bank, February 2007

[21] Lall, Somik Vinay,J. Vernon Henderson, and Anthony J. Venables,*Africa's Cities: Opening Doors to the World.* World Bank, Washington, DC, 2017 License: Creative Commons Attribution CC BY 3.0

[22] Van Hear, N. Bakewell, O. and Long, K (2012) Drivers of Migration: Migrating Out of Poverty RPC Working Paper No. 1, University of Sussex, Brighton

Migration to Kigali was more likely to be driven by pull factors than migration to secondary cities. EICV 5 asks respondents what the main reason of migration was. 70% of people who migrated to Kigali in the year before the EICV 5 survey was conducted mentioned pull factors, compared to 57% of migrants to secondary cities and 25% of migrants to rural areas. This provides evidence that people migrate to cities because they have gained employment or because they want to deepen their education. Cities in Rwanda, an especially the capital - Kigali - offer opportunity. This insight that migration to Kigali is often accompanied by a job is confirmed by recent research on unplanned settlements in Kigali conducted by Laterite[23]. In this survey that was representative of unplanned settlements in Kigali, we find that migrant household-heads were on average 15 percentage points less likely to be underemployed relative to household-heads born in Kigali; and also 7 percentage points less likely to be unemployed, compared to heads-of-households born in Kigali.

Table 7: Reasons for moving in the past year, by quintile, for adults (EICV 5)

Reason for migration	Moved from to rural area	Moved to big city or District capital	Moved to Kigali
Pull factors	25.2%	56.8%	70.0%
Push factors	34.4%	13.5%	13.0%
Other factors	40.5%	29.6%	17.0%
Total	**100%**	**100%**	**100%**

Out of all recent migrants in quintiles 1 to 3, an estimated 17% moved to urban areas; this compares to about 62% of migrants in quintiles 4 and 5. It could be that poorer households relocated to locations in the proximity of cities, but that are not yet classified as urban. Even if this were true it does not change the fact that most recent internal migrants (regardless of where they came from or where they went) were in quintile 5 (54%) and quintile 4 (17%).

[23] Laterite, *"The dynamics of unplanned settlements in the City of Kigali",* IGC, 2017

4. Geography of Firms in Rwanda

In this chapter we draw on the Population and Housing Census and Establishment Census to show where firms are located and to explain why. We do this using firm location data from the 2014 and 2017 Establishment Census and using EBM data. We include a detailed review of branches and explain that they have an important impact on the economic geography of Rwanda. Following this we look at the patterns that explain firm density. The Population and Housing Census and Establishment Census are able to track both formal and informal firms whereas EBM data can only track formal economic activity.

4.1. The spatial distribution of firms and the geographic concentration of economic activities

To deepen our understanding of the economic geography of Rwanda, we study the distribution of firms in the country. To do this, we use data from the 2014 and 2017 Establishment Censuses. We only focus on private sector establishments such as companies or household-run businesses and exclude cooperatives and associations.[24] These range from micro enterprises (1 to 3 people), to small (4-29 employees), medium (30-99 employees) and large (100+ employees) enterprises. Out of about 179,000 active private sector establishments (formal and informal) identified in the 2017 Establishment Census, about 94.8% were micro-enterprises, 4.8% small enterprises, and about 0.4% medium or large enterprises.[25]

Most small, medium and large firms are located in urban areas of the country; micro-enterprises are more evenly distributed across the territory. According to the 2017 Establishment Census, an estimated 73% of firms with 4 employees or more in 2017 were operating out of urban areas of the country. The concentration of micro-enterprises in urban areas is comparatively lower. An estimated 38% of micro-enterprises - most of which are individual businesses - were located in urban areas of the country, compared to an urbanization rate in 2017 of 18.5% based on EICV 5 data (a factor of exactly 2 to 1).

A large proportion of firms in urban areas are concentrated in Kigali. About 50% of micro-enterprises located in urban areas are located in Kigali; the same holds for 63% of small firms; 70% of medium firms and 86% of large firms. These figures demonstrate not only the demographic, but also the economic primacy of the capital city. Table 8 summarizes the number of firms by size and city in Rwanda in 2017 (we proxy for cities using the urban areas within Districts):

[24] Cooperatives and associations are excluded because the dynamics with respect to size (number of members) are very different from companies and other household businesses

[25] These stats exclude firms 2,284 establishments in the country for which employment figures were not available.

Table 8: Number of private sector firms by City in 2017 (urban areas only)

City	Number of micro enterprises	Number of small enterprises	Number of medium enterprises	Number of large enterprises
Kigali	32,069	3,907	246	136
Rubavu	5,056	354	11	4
Musanze	4,884	305	21	7
Huye	1,636	181	7	-
Rusizi	2,072	179	7	1
Muhanga	2,638	161	18	-
Nyagatare	1,291	109	4	-
Nyamata	1,348	105	3	1
Rwamagana	1,290	85	2	1
Kayonza	918	82	4	1
Byumba	1,157	65	2	-

Beyond urbanization, three key factors that influence firm-concentration in Rwanda include:

***Firm size*. Evidence convincingly shows that the geographic concentration of firms increases with firm size**. We demonstrate this by calculating a simple Herfindahl index to measure the level of concentration of firms at the District level, by size. The higher the Herfindahl score, the higher the level of geographic firm concentration. We find that with a Herfindahl score of 1723 points (0.1723 x 10000), the geographic concentration of large firms was the highest; the score decreases to 1140 points for medium sized firms, 925 for small enterprises and 410 for micro-enterprises. Large firms are not only highly concentrated at the District level, but also at the Sector level. We can explore Sector-level firm data with Establishment Census from 2014, which includes administrative Sector identifiers. In 2014, we find that the top 5 administrative Sectors of the country (out of 416 Sectors in total) were home to 30% of Rwanda's largest firms. These Sectors included Nyarugenge Sector (10% of large firms), Remera (7% of large firms), followed by Kacyiru, Kicukiro and Muhima (each with about 4% of large firms).

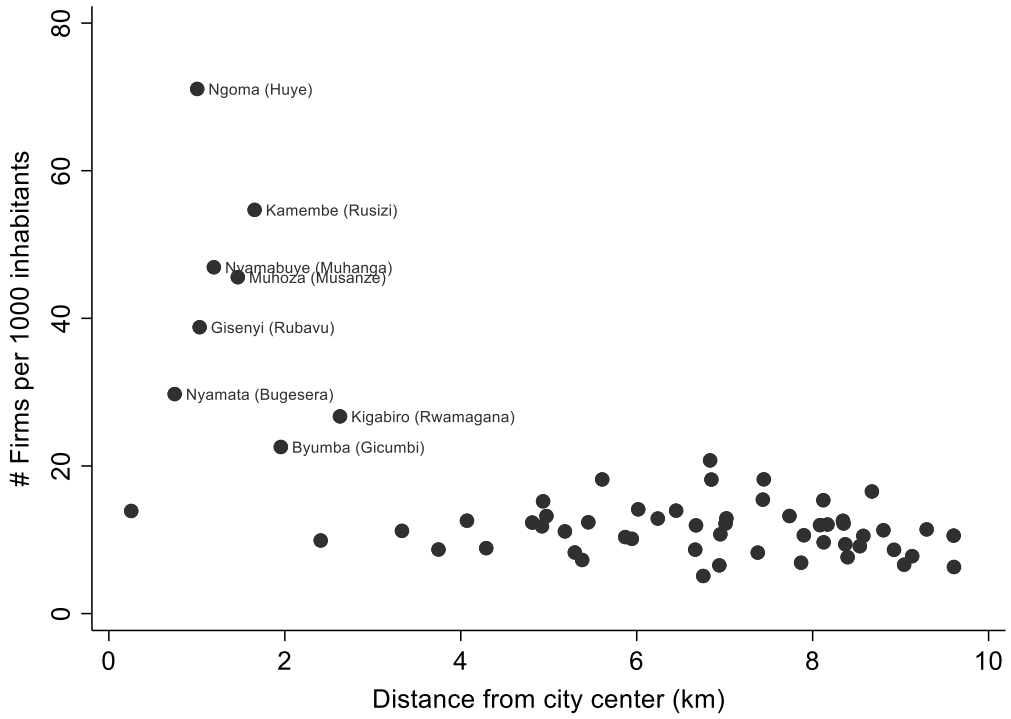
***Sectors of economic activity*. The geographic concentration of firms varies by sector of economic activity; firm concentration is highest in the most specialized activities**. The association between sector-specialization and location is studied in much more detail in the next chapter.

Proximity to city-center. **In both secondary cities and Kigali, distance to the city centre is the strongest predictor of firm density levels.** We use data from the 2014 Establishment Census, which provides us with geographic Sector-level resolution, to explore the link between distance to city-center and firm concentration in Rwanda's secondary cities (note: we have already established the link in the case for Kigali city in the previous chapter). Figure 6 shows that in the vicinity of secondary cities firms tend to be concentrated in little pockets of economic activity close to the city-centres – typically where the District offices are located.

Figure 6 also reveals that most secondary cities have only one Sector with high firm density levels. In Rubavu, only Gisenyi has a firm density level of more than 20 firms per 1,000 inhabitants; in Musanze only Muhoza; in Muhanga, the one sector with high firm density levels in Nyamabuye; in Huye, it is Ngoma; in Rusizi, it is Kamembe; Nyagatare does not have any Sectors with a firm density

level of more than 20 firms per 1,000 inhabitants. This has important implications for how we think about the economic geography of Rwanda. The fact that entire cities rely on very small pockets of dense business activity, shows that in the Rwandan context distance to the city-center is a critical success factor for businesses but also for job-seekers. In a context where transportation costs can be high, this distance can become a binding constraint to the job search process from the perspective of individuals and for the ability of a business to connect to suppliers and clients in the broader domestic trade network.

Figure 6: Number of private sector establishments per Sector, by distance to city centre (Sectors in close proximity to secondary cities and emerging towns only - Kigali excluded)



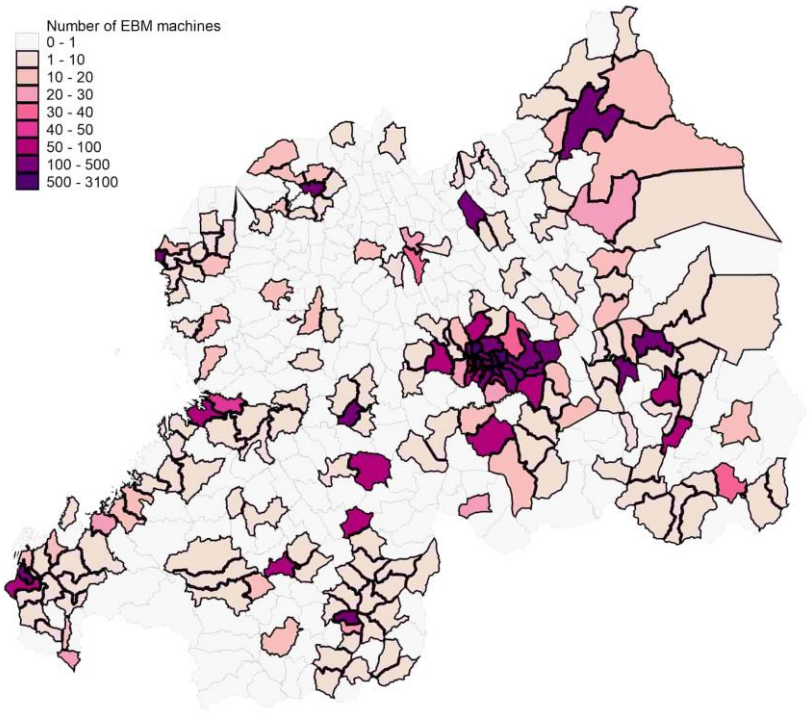
4.2. The spatial distribution of VAT registered firms

In this sub-section we look at the geographic distribution of formal-sector firms that are registered for VAT and have an EBM. Each firm in the country that is registered with the RRA and has a revenue that is greater than a certain threshold (RWF 20 million in any relevant year or RWF 5 million in a calendar quarter), has to register for VAT. With registration, comes the requirement to own an EBM machine. The RRA keeps precise location data on each of these EBM machines using an SDC registry.

The majority of EBM machines are located in Kigali, secondary cities or in areas surrounding Kigali. The EBM registry suggests that approximately 72.4% of the total stock of EBM machines – slightly more than 10,000 machines in 2018 – were based in Kigali Province. An estimated 14.9% of EBM

machines, slightly more than 2,100 machines, were operated out of secondary cities and other emerging towns (see Table 9); Rubavu and Musanze were the secondary cities with greatest number of machines (+/- 900 machines; 6.3% of the total). The remaining 12.7% of machines (+/- 1800 machines) were located in other – mostly rural - parts of the country.

Figure 7: Map representing the location of EBM machines in Rwanda (2018)



The "receipted" economy of Rwanda in 2018 covered part of the national territory. About 149 Sectors, or 35% of Sectors in the country, did not have an EBM machine in 2018. An estimated 329 Sectors, or about 80% of Sectors, had 10 EBM machines or fewer. The map depicting the location of EBM machines (see Figure 7) provides a detailed overview of the geography of Rwanda's "receipted" economy. The darkest regions of the map highlight areas of the country that are very connected to the "receipted" economy. Kigali City, and the city centre of all secondary cities and emerging towns, clearly stand out. The lightest areas represent the parts of the country that are the most disconnected from the EBM economy.

When studying EBM sales data through the lens of the economic geography of Rwanda a few clear trends emerge:

- Domestic receipted transactions are dominated by Kigali City, where 85% of sales and 80% of transactions originate;
- Rubavu, while the second largest city in terms of sales, at 1.7% of total sales weighs significantly less in the receipted economy than its population;
- The "Virunga belt", joining Rubavu to Musanze, is the area with the highest level of formal receipted transactions outside of Kigali;
- The main economic hubs outside of Kigali – including Rubavu, Musanze, Muhanga, Rusizi and Huye – are more B2C intensive.

Table 9: EBM sales and transaction statistics, by city, for 2017 sample (excluding exports)

City	Proportion of sales (%)	B2B sales over total sales (%)	Number of transactions	Proportion of EBM machines (%)
Kigali City	85.0%	62.6%	79.5%	72.5%
Rubavu	1.7%	27.8%	2.9%	3.5%
Musanze	1.5%	41.4%	1.9%	2.8%
Muhanga	1.1%	30.9%	1.7%	1.9%
Rusizi	0.8%	28.6%	1.7%	2.0%
Huye	0.7%	49.9%	2.4%	1.7%
Kayonza	0.7%	81.8%	0.8%	0.8%
Byumba	0.5%	65.7%	0.4%	0.7%
Rwamagana	0.3%	86.2%	0.0%	0.0%
Nyamata	0.3%	25.8%	1.0%	0.6%
Nyagatare	0.2%	34.9%	0.4%	0.9%
Rest of the country	7.0%	31.0%	7.2%	12.6%

Zooming-in to more granular geographical units (at the administrative Sector-level), we can see that one Sector in particular – Nyarugenge, which is the central business district of Kigali – constitutes a large portion of Rwanda's formal economy. An estimated 31% of domestic sales originate in Nyarugenge Sector, followed by Remera Sector (11%), Muhima (8%), Kicukiro (6%) and Kacyiru (4%). Combined, these five Sectors contribute to about 60% of domestic EBM sales in the country. These figures imply that economic activities in Rwanda's receipted economy are very concentrated in a small geographic area.

4.3. Branches and their impact on the economic geography of Rwanda

Firms play a very important role in the economic geography of Rwanda, not only through internal trade and their impact on the location where they are headquartered, but also through the establishment of branches in different parts of the country. These branches bring products and services to parts of the country where they were previously inaccessible. They increase the diversity of products and services available locally and the overall complexity of the local economy. Branches are very prevalent in the wholesale and retail trade industry (for example through the establishment of supermarket chains in the country), the banking and insurance industry, the telecommunications industry, the accommodation sector and the manufacturing sector.

To understand the changing economic geography of Rwanda, we cannot ignore the role of branches as they are expanding at an exponential rate. Using data from the 2014 and 2017 Establishment Census we estimate that the number of branches classified increased by an estimated 27% annually in Rwanda, compared to 6.9% for non-branches. Recent trends suggest that branches will play an increasingly important role in the economic geography of Rwanda. The rapid increase in the number of branches in secondary cities of the country suggest access to services is expanding quickly. It also suggests that firms are finding a market for their products and services in these cities.

Branches only account for a small percentage of firms in the country but explain a high proportion of sales in certain locations. From the Establishment Census we estimate that 73% of the headquarters of small, medium and large firms – with branches - in 2017 were based in Kigali. Similarly

with EBM data, we estimate that 72% of firms with at least one branch are headquartered in Kigali. The Establishment Census shows that branches accounted for an estimated 6.8% of small, medium and large firms in Kigali in 2017, compared to about 17.5% on average in secondary cities. Table 10 presents the proportion of EBM sales in each city attributable to branches. There is a lot of variation in the contribution of branches to local sales at the city-level, but certain cities stand out. In the city of Rubavu for example, branches contributed to almost 40% of total sales; in Huye, branches contributed to 35% of sales; in Nyamata about 30% of sales; in Byumba and Rusizi about 26% of sales. This may also point to an emerging pattern of functional specialization within firms: Kigali retains the headquarters where skill-intensive activities with highest value added are located, while new branches are located in secondary cities, as a consequence of lower input costs (wage and rents) or easier access to the local market. Branches are comparatively under-represented in cities such as Muhanga, Musanze, Nyagatare and Kayonza (see Duranton and Puga, 2005).

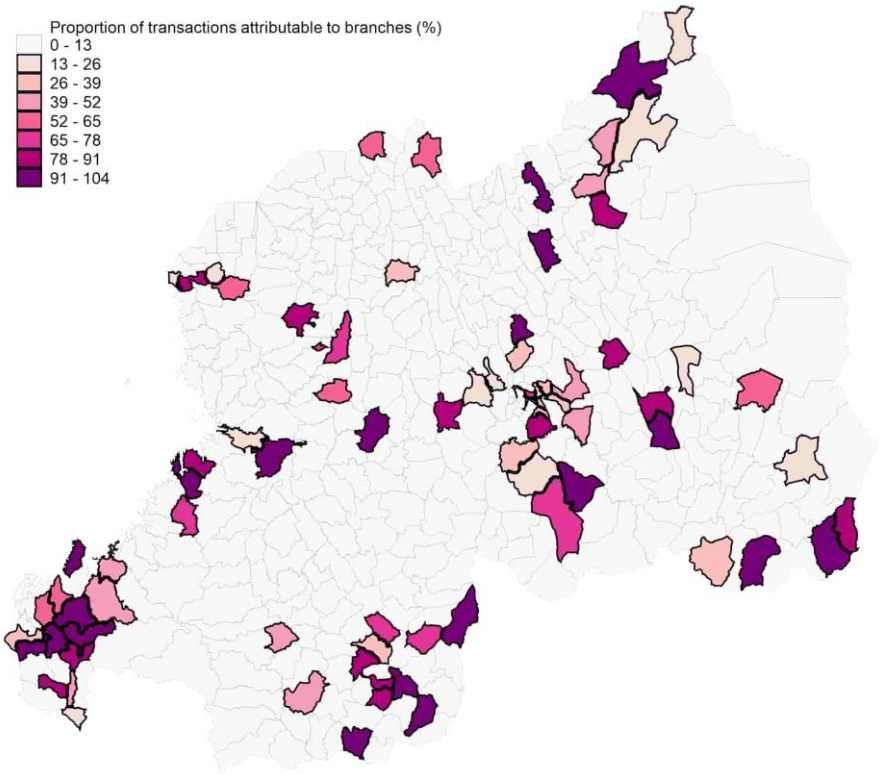
Table 10: Proportion of EBM sales attributable to branches, by District

District	Proportion of sales attributable to branches	Proportion of transactions attributable to branches	Proportion of firms that are branches (%)
Rubavu	40.3%	16.7%	12.8%
Huye	34.6%	8.7%	6.4%
Nyamata	29.5%	21.0%	15.1%
Byumba	25.9%	3.0%	4.3%
Rusizi	25.9%	3.4%	9.2%
Nyagatare	15.0%	15.0%	13.3%
Muhanga	9.8%	5.2%	5.5%
Kigali City	7.8%	16.3%	4.1%
Kayonza	3.6%	4.4%	14.9%
Musanze	3.3%	4.9%	6.0%

The strategic location of these cities on key border crossings offers one potential explanation as to why the branch economy is so important for these cities. The branches of Rwandan banks, supermarkets and accommodation providers in Rubavu and Rusizi, do not only service Rwandan customers, but also individuals and companies located in the border towns of Goma and Bukavu in DRC. The same might be true of Nyamata and Huye in the case of Burundi, and Byumba in the case of Uganda. The importance of branches in the proximity of borders is evident from

Figure 8. The figure maps the proportion of EBM transactions in each geographic Sector attributable to branches. We see that Sectors close to borders are much more likely to have a higher proportion of sales-transactions originating from branches. In the smallest Sectors – from an economic point of view - these sales can be from one branch alone. From a policy perspective, when discussing the importance of DRC and Burundi for Rwanda's economy, the onus is often put on what Rwanda can export to these markets. However it is also important to remember that Rwandan service providers provide a level of reliability and security that banks or other services providers in neighbouring countries – especially DRC and Burundi – cannot provide. Encouraging customers from across the border to come to Rwanda and benefit from the services that Rwandan providers can offer could be a very effective way to attract foreign capital to Rwanda.

Figure 8: Percentage of sales attributable to branches, by geographic Sector



4.4 Firm growth and population dynamics

The firm landscape of Rwanda is rapidly evolving. The total number of private sector establishments increased at a pace of about 7.1% per year between 2014 and 2017, with high levels of geographic variation.

Private sector establishments are increasingly concentrated in urban areas and in the capital. We estimate that the number firms increased by about 9.1% per annum in urban areas between 2014 and 2017, compared to 5.9% in rural areas. The growth in the number of private sector establishments in Kigali was an estimated 9.9% during the same period.

Kigali was not the only city that experienced a rapid increase in the number of private-sector establishments during the 2014-2017 period; secondary cities and emerging towns experienced a very rapid increase as well (see **Error! Reference source not found.**). In secondary cities such as Rusizi, M uhanga, Musanze and Rubavu the number of private sector establishments increased by more than 10% per annum during this period. This is also true for other emerging towns such as Byumba and Kayonza. We proxy for the number of firms in cities using urban areas within Districts in the 2014 and the 2017 Establishment Census data.

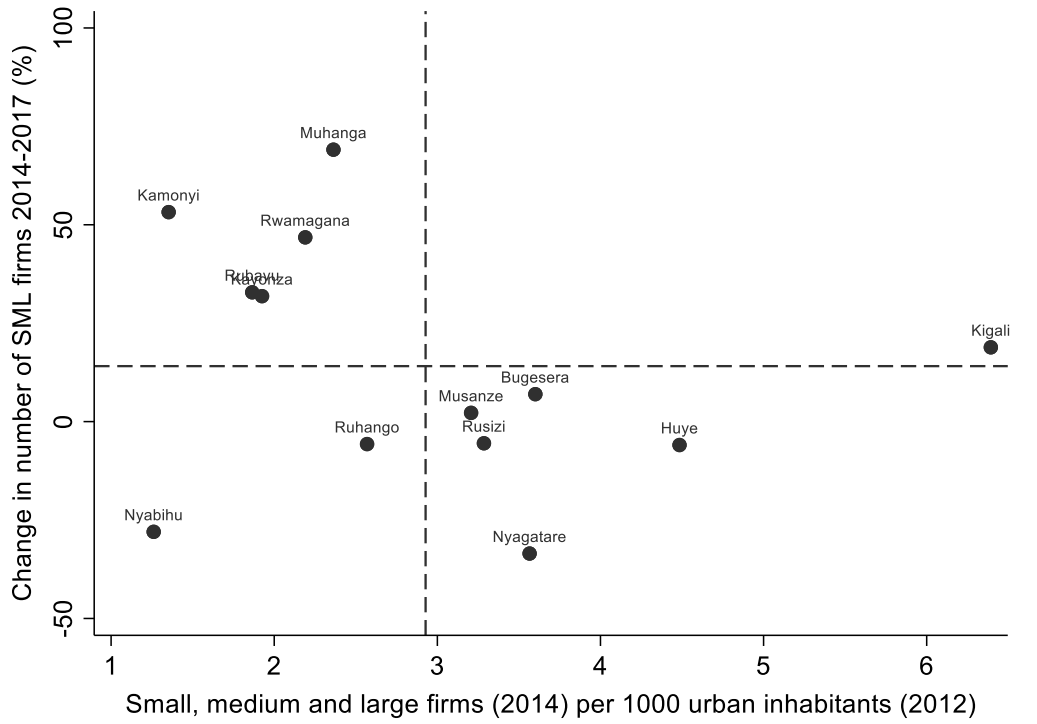
Table 11: Growth rate of private sector establishments between 2014 and 2017 (2014 and 2017 Establishment Census)

City	Estimated compounded annual growth rates in the number of private sector establishments
Kigali	9.9%
Rubavu	10.4%
Musanze	11.9%
Muhanga	11.7%
Rusizi	12.0%
Huye	7.5%
Nyamata	5.8%
Nyagatare	3.6%
Rwamagana	4.8%
Byumba	11.7%
Kayonza	13.0%

Evidence suggests that urbanization precedes the creation of small, medium and large firms (SML). There is a very clear link between the number of firms in a city and its population[26]. At the micro-level, this is not surprising since most private sector establishments are household-run single-person enterprises. The more people that live in a city, the more micro establishments we would expect to find. We also find also a strong association between the population of cities and the number of SML firms established there, albeit with more variation. Certain Districts have relatively many SML firms relative to their population, others fewer. Evidence suggests that during the 2014-2017 period, cities with a comparatively low SML firm-to-population ratio experienced a more rapid increase in the number of SML firms. Figure 9 plots the change in the number of SML firms between 2014 and 2017 against the ratio of SML firms per 1000 urban inhabitants in 2012. We can see that the cities which experienced the fastest growth rates in the number of SML firms - including Muhanga, Rubavu, Rwamagana, Kayonza and Kamonyi - all had relatively low firm-per-capita levels in 2014 (see the upper left quadrant of figure 9). We can also see that cities with relatively high SML firm-per-capita levels in 2014, all experienced a below average growth rate in the number of SML firms (see lower right quadrant of the figure). Kigali is an exception, with high SML firms-per-capita rates and continued high firm creation rates. Finally, there is another group of cities - including Ruhango and Nyabihu - that under-performed (see lower left quadrant of the figure). They had low firm-to-population ratios to start with but did not manage to grow their firm-base.

Figure 9: Number of firms and urban population levels, by District (including only cities with an urban population greater than 25,000 inhabitants in 2012)

[26] We focus only on Districts with an urban population of more than 25,000 inhabitants in 2012



Amongst Rwanda's largest cities, Rubavu stands out as the city with the lowest firm per capita rates in 2017, both with respect to small, medium and large enterprises and micro enterprises (see table 12). Mathematically speaking there are two potential explanations for Rubavu's low firms-per-capita rate: (i) either economic conditions have affected firm creation; or (ii) Rubavu's population has grown very rapidly. While we are not able to disentangle which of the two effects is strongest, we can confirm that population growth rate in Rubavu has been high. Population growth estimates based on the weights used in EICV 5 suggest that Rubavu at 4.9% was the fastest growing secondary city; population projections using the CEISN-Facebook HRSL satellite predictions for the 2012-2015 period also show that Rubavu was the fastest growing secondary city after Nyagatare, with a population growth rate of 5.5%. One potential explanation for Rubavu's low firm-per-capita ratios is that population growth has outpaced job-creation in Rubavu. It takes time for the arrival of new migrants to translate into firm creation. If low SML firm-to-population ratios is indeed an early predictor of firm growth, then Rubavu would be best positioned to continue to experience a very rapid increase in firm growth rates in the near future.

Table 12: Firms per capita in 2017 (using Establishment Census 2017 and EICV 5 population projections)

City	Small, medium and large firms per 1000 inhabitants (2017)	All firms per 1000 inhabitants (2017)
Rubavu	2.0	29.3
Nyagatare	2.0	25.8
Musanze	2.7	43.1
Gicumbi	2.7	51.1
Kayonza	2.8	33.6
Rusizi	2.8	35.3
Bugesera	3.1	43.5
Muhanga	3.3	52.5
Rwamagana	3.3	52.3
Huye	4.3	42.8
Kigali	5.0	43.2

5. The geography of structural transformation and economic complexity

In this chapter we study the composition of economic activities in Rwanda and exploit compositional differences in economic activities between regions to generate insights about the geography of structural transformation in Rwanda. Structural transformation is a very important topic when it comes to urbanization and spatial economic development. In a recent paper that revives the discussion on the link between urbanization and structural transformation, Henderson and Kriticos highlight how the convention in the literature - that urbanization is intricately linked to a shift towards a more modern economy and structural transformation - has been challenged by the recent experience of urbanization in Sub-Saharan Africa (Henderson and Kriticos, 2017)[27]. The authors demonstrate that urbanization in Africa has happened despite low productivity in the agriculture sector, has led to limited industrialization and has happened in parallel to a high share of primary sector employment in cities, especially in secondary cities.

Our objective in this chapter is to explore what differences in the composition of activities by location in the Rwandan context can tell us about: (i) the level of structural transformation of a certain location; (ii) which activities distinguish more economically advanced locations from less developed parts of the country; (iii) which activities different regions of the country can aspire to, given their current activity-mix; and (iv) how the economic composition of activities links to the geography of the country.

To map the sectoral composition of economic activities in Rwanda we use employment data from the 2012 Population and Housing Census. Although 6 years old, we choose to work with Census data because:

- It provides us with granular data at the geographic level – with about 1m data points in the publicly available dataset we have enough precision at the geographic Sector level;
- It provides us with more detailed ISIC economic activity classifications than alternative data – in the Census data ISIC classifications are available at the 2,3 - and 4 - digit level, which is not the case in other publicly available datasets;
- It provides a more complete picture of the economy than the Establishment Census, which almost entirely excludes the agriculture Sector (agricultural establishments are mainly

[27] Henderson, J. Vernon and Kriticos, Sebastian (2017*), The development of the African system of cities*, Annual Review of Economics. ISSN 1941-1383

captured in the form of cooperatives, there are very few private-sector firms working in the agriculture space) and is heavily dominated by firms in Kigali;
- It provides us with sufficient statistical power at the industry-location level, which is not the case of other datasets, including the Labour Force Surveys or EICV 5;
- Combined with data from the 2002 Housing and Population Census, it allows to make predictions moving forward and to test our assumptions.

The main analytic framework we use throughout this chapter is based on the economic complexity methods put forward by Hausmann, Hidalgo (2007[28],2013[29]). Economic complexity is a compositional measure that collapses all the information about the composition of a country or a region's economy (be it the structure of exports, the labour market, firms, patents) into a score. Throughout this chapter we interpret this score a relative measure of structural transformation in a certain location. Note that economic complexity provides a relative score, in this case on a scale of 0 to 100, where the least complex location in the country obtains a score of 0 and the most complex location a score of 100. We explain this methodology in more detail below.

5.1. Brief overview of structural transformation in Rwanda

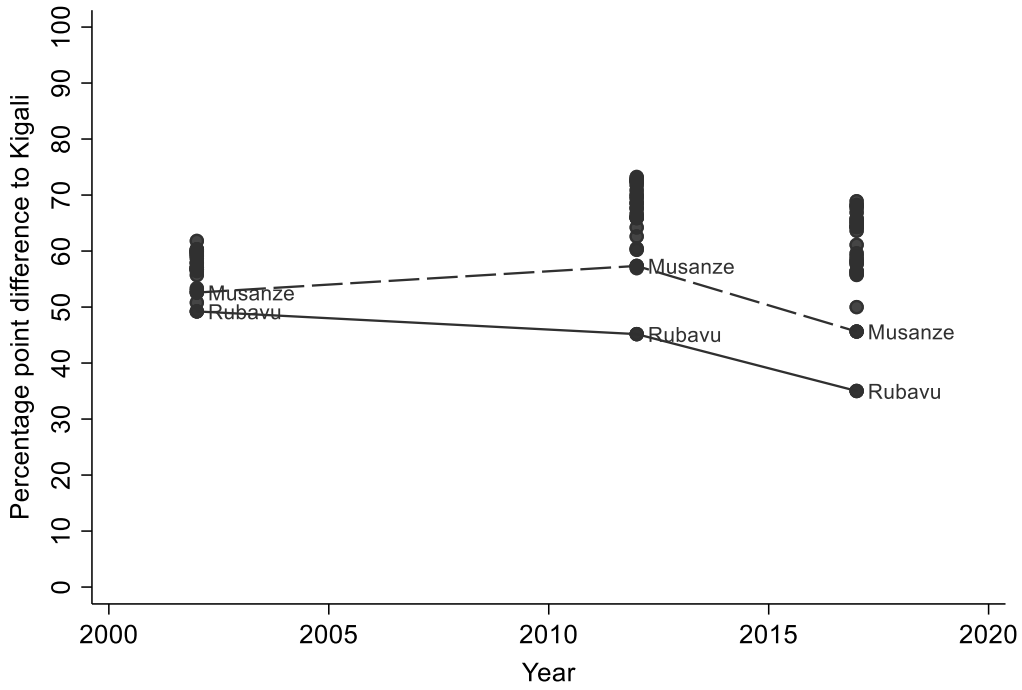
Rwanda has been experiencing a gradual structural transformation of its economy, away from agricultural activities, towards non-agricultural activities in both the services and manufacturing sectors. According to the 2002 Housing and Population Census data, an estimated 87.7% of the working population was employed in agriculture; this number had decreased to 75.2% by 2012 according to the 2012 Housing and Population Census; it decreased further to about 66.7% according to the 2016-2017 EICV 5 survey.

However, at the national level - with few exceptions - we observe little convergence in the pace of structural transformation over the past 15 years between Kigali and other Districts. The proportion of the population working in agriculture (as their main activity) decreased in Kigali Province from an estimated 39% of the population in 2002 (based on estimates from the Population Census on the main activity over the past 30 days), to about 14% in 2016-2017 (based on data from EICV 5 on the main activity over the past 7 days). During the same period, the share of the population working in agriculture in other Districts decreased from 92% in 2002 to 75% in 2016-2017. The average gap between Kigali and other Districts in terms of the proportion of the employed population working in agriculture was 57 percentage points in 2002; it increased to 67 percentage points in 2012; and decreased to 60 percentage points in 2016-2017 (slightly higher than the gap in 2002). While the structure of Rwanda's economy is changing country-wide, the growth of urban centers outside of Kigali have not yet led to an economic convergence or a "catch-up" process with Kigali. On the contrary, evidence suggests that if anything the gap has slightly widened.

[28] Hidalgo, Caesar & Hausmann, Ricardo, *The Building Blocks of Economic Complexity*, Proceedings of the National Academy of Sciences of the United States of America, 2009

[29] Hidalgo, Caesar & Hausmann, Ricardo, *The Atlas of Economic Complexity : Mapping Paths to Prosperity. Cambridge*, MA :The MIT Press, 2013. Print.

Figure 10: Difference in the proportion of the employed workforce in agriculture comparing Kigali to other Districts between 2002 and 2017 (looking at main activity only)



Census data used for 2002 and 2012; EICV 5 data for 2016-2017

**Note that 2016-2017 employment data from EICV 5 is not directly comparable to Census data from 2002 and 2012; the Census data on employment captures the main activity of work for the past 30 days; EICV 5 data used here captures the main activity of employment that people have been engaged in over the past 7 days.*

The two exceptions that stand out are Rubavu and Musanze Districts, which have started gradually converging towards Kigali in terms of the proportion of the employed population still working in agriculture (see figure 10). In 2002 an estimated 84% of the working population in Rubavu District reported agriculture as their main economic activity, compared to an estimated 49% in 2016-2017 (a drop of about 35 percentage points); during the same period, the proportion of the employed population working in agriculture in Musanze District decreased from 88% in 2002 to an estimated 60% in 2016-2017 (a drop of about 18 percentage points). Even though the gap with Kigali remains large in percentage point terms, it is not such a large gap when viewed over time. As a point of reference, the proportion of the working population in agriculture is very similar in Rubavu District today to what it was in Gasabo District in 2002. Rubavu and Musanze Districts share a border and are home to Rwanda's second and third largest cities. These cities, and related urban areas along the "Virunga Belt", are the only areas of the country that have succeeded in not only pulling a large population out of agriculture, but also started converging towards Kigali in terms of the composition of economic activities.

5.2. The composition of economic activities by District and patterns of revealed comparative advantage

We next focus on studying the composition of economic activities by District using employment data from the 2012 Population and Housing Census, measured here at the ISIC 3 level. **Census data provides us with sufficient granularity at the District-activity level; this is not the case of the EICV data or the LFS data.** We make comparisons at the District level, and do not limited ourselves to only urban areas, so that the units of analysis are comparable in terms of population size. We do not consider any activities employing less than an estimated 500 people nationally; we also do not count any activity as being present in a District if it employs fewer than 150 people in that District. These cut-off points are arbitrary; we put them in place in order to avoid making extrapolations based on very little data. Furthermore, please note that this analysis is based on where people live, not where they work.

As an example of what differences between Districts look like, we compare the composition of sectors of employment in Kigali Province, to the Districts of Huye, Muhanga, Musanze, Nyagatare, Rubavu and Rusizi – which are home to Rwanda's six secondary cities. The largest sector of employment for all Districts in Rwanda in 2012 was the ISIC 3 classification of growing non-perennial crops; Kigali however clearly stands out. In Kigali Province the proportion of the population that in 2012 was involved in crop growing was about 13%, compared to over 55% or more in all other Districts in the country (see

Table 13). These statistics show how concentrated and how rural economic activities are outside of Kigali. Other sectors that weigh significantly on employment in all Districts – and in particular in urban areas – include the domestic personnel sector, construction, land transportation and retail. Kigali Province has the largest proportion its workforce employed in each of these Sectors. There are also differences between other Districts: Huye has the highest proportion of its workforce working as domestic personnel; Musanze is relatively more active in the construction sector; Rubavu having the largest proportion of people in the retail sector, and so forth.

Given that the structure of the workforce is quite concentrated, in particular in Districts outside of Kigali, it becomes difficult to draw out differences between Districts by studying the proportion of the workforce in activities that are less represented.

Table 13: Distribution of the employed population by area of activity and by District (2012 Population Survey) – top 10 ISIC 3 categories in Kigali listed

Sector of Economic Activity (ISIC 3)	Kigali Province	Huye	Muhanga	Musanze	Nyagatare	Rubavu	Rusizi
Growing of non-perennial crops	12.9%	67.2%	65.0%	70.7%	79.0%	56.7%	79.8%
Domestic personnel	10.5%	4.0%	2.5%	1.7%	0.8%	2.4%	1.5%
Construction of buildings	10.0%	3.8%	4.2%	4.6%	2.5%	4.5%	1.7%
Other land transport	6.8%	2.1%	1.8%	2.0%	1.2%	3.2%	1.5%
Retail sale via stalls and markets	5.8%	1.6%	1.5%	3.0%	1.4%	6.2%	2.3%
Retail sale in non-specialized stores	3.7%	1.3%	1.6%	1.4%	0.9%	2.5%	1.1%
Spinning, weaving and finishing of textiles	2.2%	0.7%	1.0%	1.2%	0.6%	1.1%	0.7%
Maintenance and repair of motor vehicles	2.2%	0.3%	0.3%	0.4%	0.2%	0.5%	0.2%
Goods and services for own use	2.2%	0.4%	0.3%	0.3%	0.2%	0.4%	0.1%
Public sector	2.2%	0.8%	0.5%	0.7%	0.4%	0.9%	0.4%

To overcome this issue and to bring out the differences between Districts more clearly we study patterns of "revealed comparative advantage." Following Balassa et al (1965), we say that a District has a revealed comparative advantage in a certain sector of economic activity, if the proportion of the employed population working in that sector is higher than the national average. The level of "revealed comparative advantage" or RCA of a District in each activity X is the ratio of: (i) the proportion of working people in that District employed in activity X; over (ii) the proportion of people employed in activity X nationally. For example if 25% of the employed population in a given District work in activity X, compared to 50% nationally, then the RCA of that District in activity X is 25%/50%=0.5. If on the contrary only 10% of people worked in that activity, then the RCA of that District in activity X would have been 25%/10%=2.5. Any score above 1 indicates that the proportion of the working population in that activity is higher than the national average and the District has a "revealed comparative advantage" in that activity. The underlying assumption is that if a particular location has a higher concentration of people working in a given sector than the national average, then it must be relatively good at that activity compared to other Districts.

Districts in the Province of Kigali have a revealed comparative advantage in high-skill activities.

Table 14 lists the top 5 activities – with the highest RCA - by District of Kigali, where at least 150 people were employed. The list of activities across Districts includes transportation services (air transport, the sale of motor vehicles, automotive fuel), technical and consulting services (advertising, management consulting, scientific activities), wholesale services and the security sector. These activities are all

associated with the functioning of a large city. Some of these activities require a highly trained workforce and a high degree of specialization.

Table 14: Activities in which Kigali has the highest Revealed Comparative Advantage

District	Rank	ISIC 3 activity	Revealed comparative advantage	Estimated number of workers (>150)
Gasabo	1	Sale of motor vehicles	7.5	230
Gasabo	2	Security systems service activities	6.4	830
Gasabo	3	Retail sale of automotive fuel in specialized stores	6.4	360
Gasabo	4	Building completion and finishing	6.4	370
Gasabo	5	Other professional, scientific and technical activities n.e.c.	5.9	430
Kicukiro	1	Passenger air transport	17.7	500
Kicukiro	2	Manufacture of paper and paper products	12.6	170
Kicukiro	3	Advertising	12.5	220
Kicukiro	4	Management consultancy activities	11.0	190
Kicukiro	5	Manufacture of other chemical products	10.4	240
Nyarugenge	1	Wholesale of household goods	20.6	1,610
Nyarugenge	2	Goods and services for own use	19.9	8,220
Nyarugenge	3	Wholesale of machinery, equipment	14.5	560
Nyarugenge	4	Wholesale of food, beverages	12.9	1,420
Nyarugenge	5	Security systems service activities	11.1	730

Key urban areas outside of Kigali have a comparative advantage in a very different set of activities, some of which are more or less knowledge intensive. **There is overlap between the specific branding of themes that have been given to cities in the 2015 Spatial Development Framework and the areas in which cities had a revealed comparative advantage in 2012**. Huye, which is branded as the city of "Education, Knowledge and Cultural History" had a revealed comparative advantage in research and higher education; "Rubavu", which is branded as the city of "International gateway city and tourism", had a revealed comparative advantage in accomodation and retail/trade; Rusizi which is branded as "cross border trade and transportation logistics, Nyungwe Forest", had a revealed comparative advantage in transportation activities; Muhanga which is branded as the city of "Hydropower and mining centre, creative economy, pottery and fashion" had a revealed comparative advantage in mining; and Nyagatare, which is branded as "cattle and dairy region/commercial hub of eastern region", had a revealed comparative advantage in animal production. Musanze is branded as the city of "eco-friendly mountain tourism and industry", but in this case the overlap with the revealed comparative advantage metric is less clear-cut.

Table 15 presents the 3 activities with more than 150 workers with the highest levels of RCA, by District. Huye, in line with its historic strength in university-level education, has a comparative advantage in scientific research, higher education, but also support activities to agriculture. Rusizi for example stands out through its fishing sector and support activities for the transport sector; Rubavu has the highest RCA in the manufacturing of beverages (Bralirwa), as well as a comparatively high proportion of its workforce in retail and accommodation sectors; Musanze specializes in road construction, community services and has a high proportion of its workforce in the retail sector; Muhanga in mining, non-classified ("other") types of manufacturing and farming.

There is overlap between the specific branding of themes that have been given to cities in the 2015 Spatial Development Framework and the areas in which cities had a revealed comparative advantage in 2012. Huye, which is branded as the city of "Education, Knowledge and Cultural History" had a revealed comparative advantage in research and higher education; "Rubavu", which is branded as the city of "International gateway city and tourism", had a revealed comparative advantage in accomodation and retail/trade; Rusizi which is branded as "cross border trade and transportation logistics, Nyungwe Forest", had a revealed comparative advantage in transportation activities; Muhanga which is branded as the city of "Hydropower and mining centre, creative economy, pottery and fashion" had a revealed comparative advantage in mining; and Nyagatare, which is branded as "cattle and dairy region/commercial hub of eastern region", had a revealed comparative advantage in animal production. Musanze is branded as the city of "eco-friendly mountain tourism and industry", but in this case the overlap with the revealed comparative advantage metric is less clear-cut.

Table 15: Activities in which urban areas outside of Kigali have the highest Revealed Comparative Advantage

District	Rank	ISIC 3 activity	Revealed comparative advantage	Estimated number of workers (>150)
Huye	1	Research and experimental development on natural sciences and engineering	22.8	230
Huye	2	Support activities to agriculture and post-harvest crop activities	10.9	1,590
Huye	3	Higher education	5.6	580
Muhanga	1	Growing of perennial crops	2.7	11,380
Muhanga	2	Manufacture of non-metallic mineral products n.e.c.	1.9	1,190
Muhanga	3	Mining and quarrying n.e.c.	1.5	510
Musanze	1	Construction of roads and railways	1.8	290
Musanze	2	Provision of services to the community as a whole	1.7	1,130
Musanze	3	Retail sale via stalls and markets	1.6	4,280
Nyagatare	1	Animal production	2.6	3,880
Nyagatare	2	Repair of personal and household goods	2.0	610
Nyagatare	3	Restaurants and mobile food service activities	1.4	600
Rubavu	1	Manufacture of beverages	4.6	400
Rubavu	2	Retail sale via stalls and markets	3.2	6,910
Rubavu	3	Short term accommodation activities	3.1	660

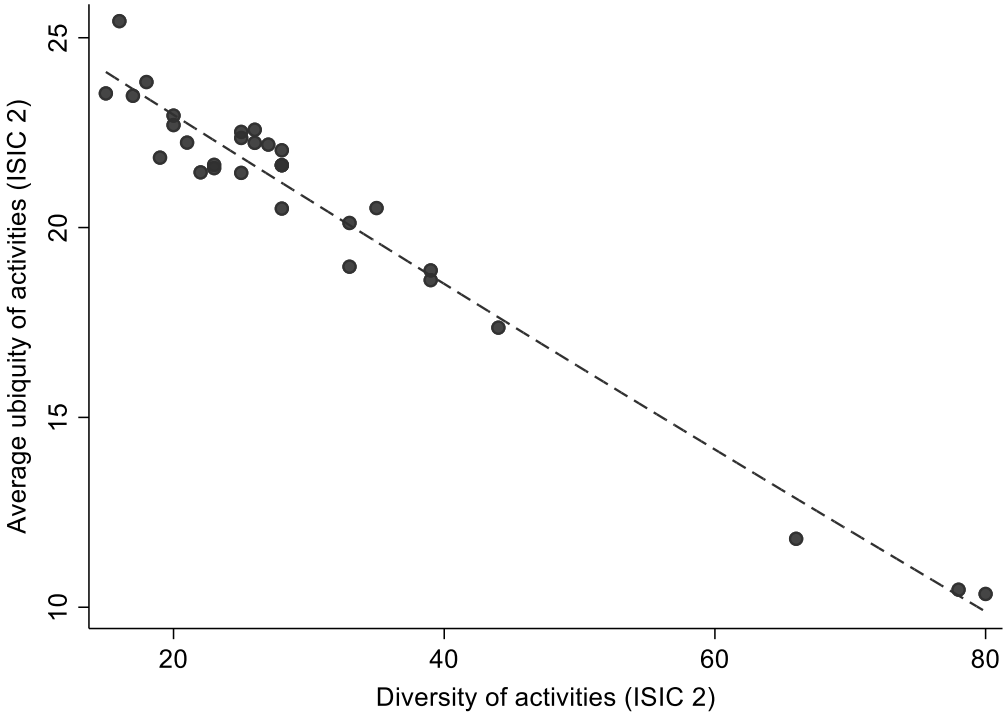
Rusizi	1	Fishing	5.0	570
Rusizi	2	Support activities for transportation	2.2	1,290
Rusizi	3	Photographic activities	2.2	160

Districts differentiate themselves not only through the activities in which they have the highest RCA score, but the number of activities in which they are active. We refer to the number of activities in which a District is active as its "diversity." We say that a District is active in a sector if it has an RCA of at least 0.5 in that sector (we consider any score below 0.5 as too small to be meaningful). We decided to calibrate the RCA to 0.5 in order to take into account the fact that in most sectors of the economy, almost all workers in that sector are based in Kigali. Applying a higher RCA of 1 for example, would lead to us underestimating the number of activities Kigali is active in[30]. Using these parameters Kigali's three Districts have the highest diversity levels: Gasabo has a revealed comparative advantage in 80 different ISIC 2 activities; Kicukiro in 78 and Nyarugenge in 66 (note that this based on where people lived in 2012, not where they worked). Rubavu has a diversity level of 44, Huye of 39, Musanze 39, Muhanga 35, Rusizi 33 and Nyagatare a level of 26. If a location is good at many different things, then we would expect its level of economic development to be higher.

Another factor that differentiates Districts, is how specialized the activities in which they have an RCA of more than 0.5 are. A basic proxy for the level of specialization of an activity is its "ubiquity". Following Hausmann, Hidalgo, we define the ubiquity of an activity as the number of Districts that are involved in that activity. For example if 10 Districts are involved in a given activity, then its ubiquity would be 10. The underlying logic is that the fewer the number of locations that involved in an activity, the more specialized this activity is. Not all products with low levels of ubiquity are highly specialized activities, but almost all activities with a high level of specialization have low levels of ubiquity. Once we've calculated the ubiquity of each activity within the context of Rwandan Districts, it is possible to calculate the average ubiquity of the activities in which a District has a revealed comparative advantage.

Figure 11: Diversity and average ubiquity of ISIC 3 activities, by District, based on 2012 Population and Housing Census

[30] The selection of the RCA cut-off point is arbitrary; it is good practice to vary it and make estimates using different thresholds. In this case we select a level of 0.5 as we believe it provides us with the most accurate picture of the sectors in which cities have a revealed comparative advantage



We find that within the Rwandan context – and this is true in many other contexts as well - Districts with highest levels of diversity also have the highest levels of specialization. Figure 11 plots the average ubiquity of Districts, versus their diversity, based on ISIC 2 activities. We see a very clear downwards sloping association emerging. Districts with high diversity levels, tend to specialize in activities that other Districts do not specialize in. These tend to be comparatively more sophisticated activities.

5.3. Economic complexity and the level of structural transformation

We can further exploit differences in the composition of economic activities by District to derive estimates of the economic complexity of Districts in Rwanda. The concept of economic complexity (see Hausmann and Hidalgo, 2009) is based on the notion that the most "complex" economies have many different capabilities. The combination of these capabilities allows them: to produce many different products and services; including highly specialized products and services, that are rare (non-ubiquitous) in the rest of the economy. Using the terminology introduced above, the most "complex" economies have high levels of diversity and specialize in the least ubiquitous products. From the discussion above we can see clearly that Kigali stands out in terms of both its diversity and the average ubiquity of its economic activities. Firms in Kigali engage in economic activities - such as computer programming, air transport, the manufacturing of chemicals, etc - that are not present in other locations of the country. While the status of Kigali as the most advanced economy in the country is clear, less is known about the comparative situation of other Districts.

To construct an economic complexity score for Rwandan Districts we follow two steps: (i) we first combine the information on the revealed comparative advantage of Districts into a location-activity matrix; (ii) we then use this matrix to compute an economic complexity score, following the method of reflections introduced by Hausmann, Hidalgo (2009). The location-activity matrix includes each District (proxied for by urban areas within Districts) in its rows and each ISIC 3 activity in the columns. The elements of the matrix take the value 1 when a District has a revealed comparative advantage of more than 0.5 in the corresponding ISIC 3 activity and a 0 otherwise.

Using this matrix, we calculate an economic complexity index for each District following the method of reflections. For the purposes of this report we do not go into the details of the calculations, but instead focus on the intuition. This complexity score is based on a dimension reduction technique that takes all the information in the matrix and collapses it into a complexity score for each location; and a complexity score for each activity. The higher the complexity score, the higher the complexity of economic activities in that location. The complexity score rewards locations that are involved in many different activities (the more diverse an economy, the higher the score); it also rewards locations that are involved in highly specialized activities (which means non-ubiquitous activities that are most likely to be present in the most advanced locations of Rwanda). Since it is a compositional score, it can be thought of in this context as a measure that captures the relative level of structural transformation of a location.

An estimate of the economic complexity of Rwandan Districts, derived from workforce composition data, confirms: (i) that Kigali's three Districts have by far the most diverse and specialized economies of Rwanda; (ii) that the second most diverse and specialized economy is Rubavu District; and (iii) that the workforce composition is relatively similar in Musanze, Rusizi and Huye Districts. This example shows how we can use the composition of economic activities to derive insights about their relative ranking in terms of economic development.

Table 16: Economic Complexity Index applied to Establishment Census data, by District

Rank	District	Economic Complexity (0= least complex; 100 = most complex)
1	**Gasabo**	100.0
2	**Kicukiro**	97.9
3	**Nyarugenge**	85.7
4	**Rubavu**	34.2
5	**Musanze**	25.0
6	**Rusizi**	23.5
7	**Huye**	21.3
8	**Muhanga**	14.6
9	**Rwamagana**	14.5
10	**Nyabihu**	12.6

11	**Kayonza**	11.0
12	**Ruhango**	10.7
13	**Karongi**	9.6
14	**Rulindo**	8.8
15	**Gakenke**	8.7
16	**Nyagatare**	8.6
17	**Gicumbi**	8.2
18	**Nyanza**	8.2
19	**Kamonyi**	8.1
20	**Nyaruguru**	7.6
21	**Ngororero**	7.2
22	**Nyamasheke**	6.8
23	**Gatsibo**	6.7
24	**Nyamagabe**	6.2
25	**Burera**	5.6
26	**Bugesera**	5.2
27	**Ngoma**	2.2
28	**Rutsiro**	2.2
29	**Gisagara**	2.0
30	**Kirehe**	0.0

From an activity perspective, economic complexity analysis allows us to identify which sectors of economic activity were associated with a high level of economic complexity. In

Table 17 and Table 18 we list the sectors of economic activity that this methodology classifies as the most and the least complex in Rwanda (and in which at least 500 people were employed in 2012).

Table 17: Complexity score of 10 most specialized economic activities in Rwanda in 2012 (in which more than 500 people were working)

ISIC 3	Product complexity	Economic Activity
454	100	Sale, maintenance and repair of motorcycles and related parts and accessories
741	100	Specialized design activities
451	100	Sale of motor vehicles
511	98.9	Passenger air transport
941	98.9	Activities of business, employers and professional membership organizations
202	98.9	Manufacture of other chemical products
701	98.9	Activities of head offices

432	98.9	Electrical, plumbing and other construction installation activities
702	98.9	Management consultancy activities
433	98.9	Building completion and finishing
854	98.9	Other education

Table 18: Complexity score of 10 most least specialized economic activities in Rwanda in 2012 (in which more than 500 people were working)

ISIC 3	Product complexity	Economic Activity
131	13.6	Spinning, weaving and finishing of textiles
563	13.4	Beverage serving activities
851	13.0	Pre-primary and primary education
15	12.0	Mixed farming
14	11.2	Animal production
982	9.9	Undifferentiated service-producing activities of private households for own use
16	4.1	Support activities to agriculture and post-harvest crop activities
11	4.0	Growing of non-perennial crops
12	1.1	Growing of perennial crops
22	0.3	Logging
31	0.0	Fishing

5.4. Economic complexity and structural transformation

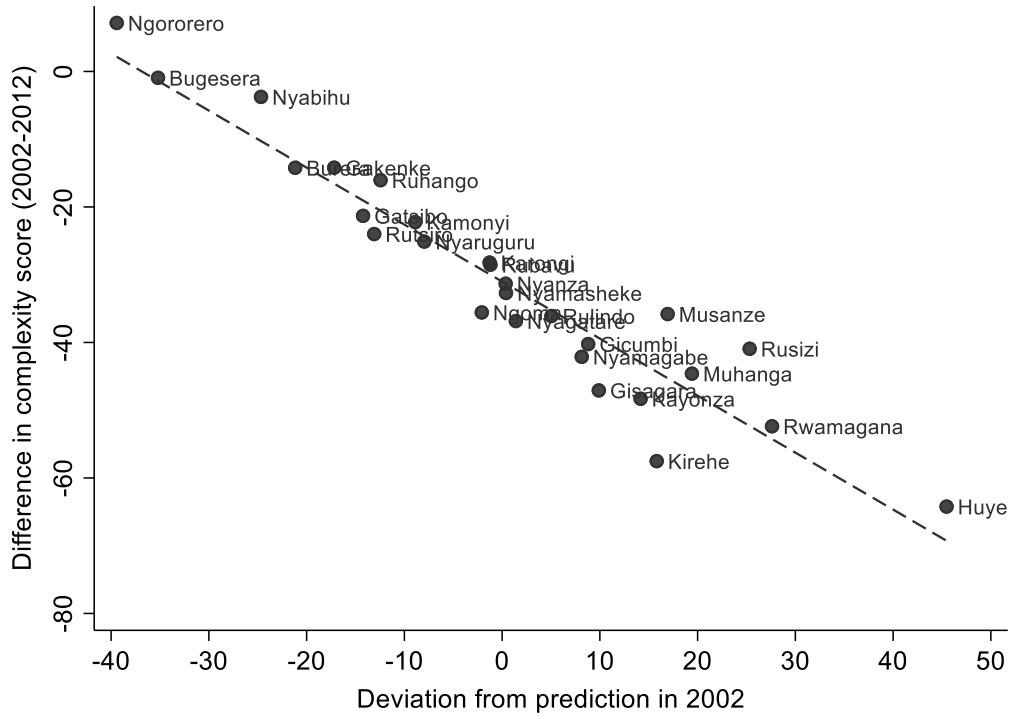
This measure of economic complexity - which we interpret here as a measure of the relative level of structural transformation of a District - is useful because it can help us gain insights into future economic trends.

We use data from the 2002 and 2012 Population and Housing Censuses to show that population density precedes structural transformation in the Rwandan context, captured here by the economic complexity index. There is a strong correlation between population density and complexity (we see this in both 2002 and 2012). Locations with higher levels of population density - which are comparatively more urbanized - are associated with higher levels of economic complexity. This association is positive, statistically significant, but non-linear.

To show that population density precedes structural transformation, we do three things: First, we predict the level of complexity of all Districts based on their population density in 2002[31]. Comparing this prediction to the actual levels of economic complexity measured in 2002, we find that certain locations have higher levels of complexity than anticipated given their level of population density; while other locations have lower levels of complexity than anticipated. We capture this difference between the actual complexity and the predicted complexity in a separate variable, called the residual. Next we compare this residual to the change in the relative complexity of Districts between 2002 and 2012. As can be seen in figure 12, this residual is very strongly predictive of the change in the relative complexity score of a District between 2002 and 2012 (note that in both 2002 and 2012 the scores are relative, ranging from 0 for the lowest complexity District, to 100 for the most complex District). Districts that had a higher complexity score in 2002 than expected, saw their relative level of economic complexity decrease faster than other Districts; Districts that had a lower complexity score experienced a much slower decrease (note that this decrease is not an absolute decrease in complexity, but rather a relative decrease compared to Kigali). We find very similar results when doing these calculations at the Sector level, instead of the District level. The signal we obtain is unusually strong, with an R-squared of 90% in the cases of Districts, suggesting that population density precedes structural transformation in Rwanda.

Figure 12: Difference in the estimated District complexity scores between 2002 and 2012 vs residual from the prediction in 2002 (excluding Kigali)

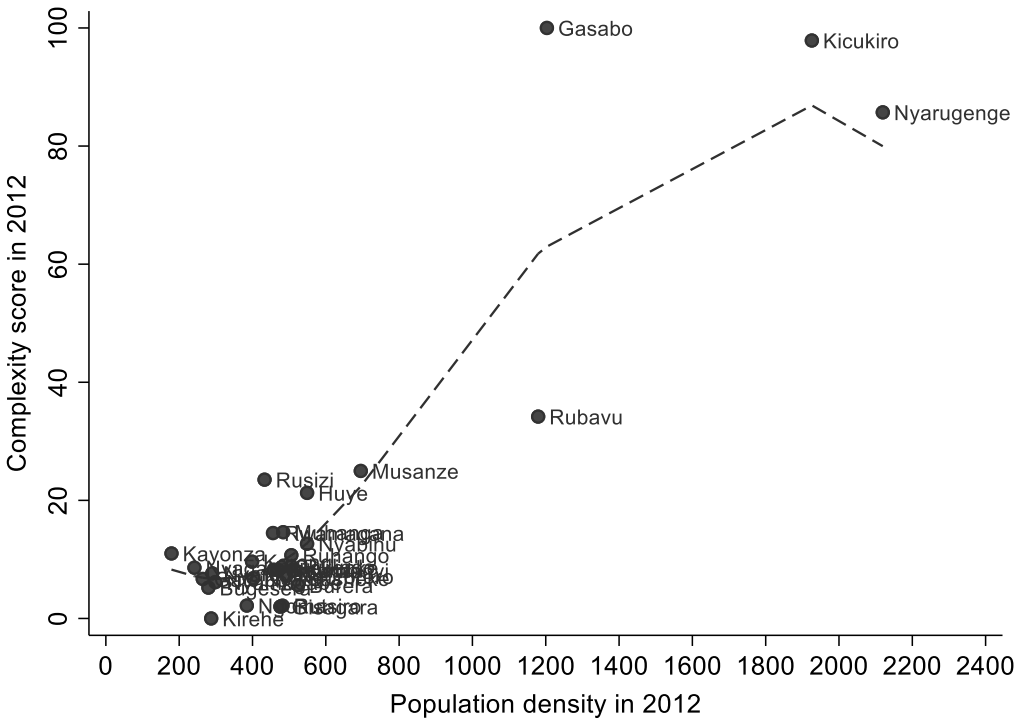
[31] We run this regression using a simple kernel-based non-parametric regression called KRLS (Hainmueller, 2014) where complexity in 2002 is the dependent and the population density of a District Is the only explanatory variable. We capture the residual or error of this regression in a separate variable.



If this finding holds over time, then a similar exercise focusing on differences between predicted complexity levels versus actual complexity levels applied to 2012 data, could potentially provide us with useful insights about future trends in the geography of structural transformation in Rwanda during the 2012-2022 period. We follow the same procedure as above calculate the difference between actual and predicted economic complexity. The dotted line depicted in figure 13 depicts the predicted complexity level of Districts in 2012, based on the density of their population. District that fall below the dotted line have a lower complexity level than expected; Districts above the dotted line have a higher level complexity than anticipated given their population density levels.

If population density precedes structural transformation in the Rwandan context, then we would expect Rubavu District to have by far the highest potential for future convergence. There is a clear disconnect between Rubavu's population density levels and its economic complexity levels. In fact in 2012, Rubavu had a similar population per capita as Gasabo District, but with a much lower level of economic complexity. This is consistent with findings presented above on the pace of convergence between Rubavu District and Kigali Province, when it comes to the proportion of the employed labour force working in the agricultural sector. Between 2012 and 2017, Rubavu District experienced the fastest convergence, with a sharp drop in the proportion of the workforce employed in agriculture. This is also consistent with findings on the firms and city population levels, where it is again Rubavu District that shows the highest potential for convergence.

Figure 13: Complexity score in 2012 and population density in 2012, by District



5.5. The smart specialization framework applied to Districts and Sectors in Rwanda

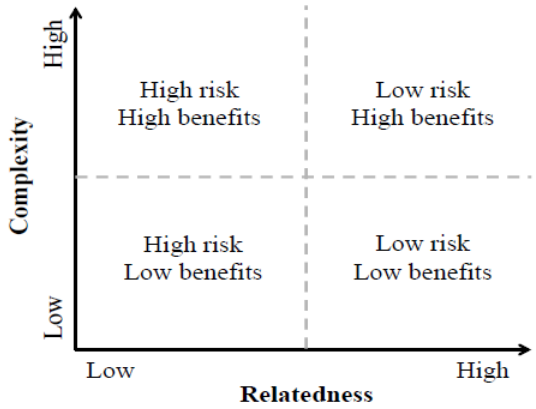
One recent addition to the complexity literature by Balland et al (2018), focuses on the concept of smart specialization. Smart specialization is a term that was first used between 2006 and 2009 by policy makers when thinking about regional development within the EU and how regions could position themselves strategically within the knowledge economy. Balland and his co-authors propose a Smart Specialization framework to guide policy makers in their selection of potential target sectors using a combination of complexity and network theory[32]. It is a tool - and nothing more than a tool - to help policy makers think in a data-driven way about developing regional economic specialization strategies. The Smart Specialization concept is based on two pillars: (i) the economic complexity of activities; and (ii) the "relatedness" of a geographic location to those activities. This framework aims to help policy makers prioritize economic activities, based on how "complex" they are, and based on how achievable they are for a given location. Before we explain this conceptual framework, we first briefly explain what "relatedness" means in this context. We do not go into the details of the calculations, but rather provide the intuition. We apply it here to the Rwandan context to draw some insights about the potential or not for targeted regional economic specialization strategies. It is relevant in the context of the policy debate on spatial development in Rwanda and the question of whether to focus on a location-based sector specialization policy.

Relatedness is a measure of how realistic it is for a geographic location to enter a new economic activity, given its current strengths. Certain economic activities are more related than others. For example if the main activities Musanze specialized in included tires and motors, then it would be comparatively easier for Musanze to start producing cars than to kick-start a chemicals industry. Similarly, if Huye specialized in the production of computer chips and transistors, then it would be comparatively easier for Huye to start producing mobile phones rather than to enter the production of cruise-ships. Data from around the world, be it export-related, patent-related or industry-related, confirms that geographic locations are more likely to develop into related economic activities than into unrelated economic activities (see work on the principle of relatedness by Hidalgo et al, 2018). This is both logical and measurable. The distance between pairs of economic activities - for example the production of cars and tires - can be measured by looking at the how frequently both activities appear in a same location. For example, if most car-producing locations also produce tires, then the production of tires and cars are likely to be related activites. It is also possible to measure the distance between all the activities a given location specializes in, and another activity it has yet to enter. This is what we call "relatedness". Knowing which activities a District specializes in now is informative about which economic activities it might enter in the future.

The question we ask here is therefore: given what we know about the current set of economic activities of Districts and Sectors in Rwanda, what type of economic activities are they more/less likely to enter in the future?

This Smart Specialization framework is based on the premise that a good location-based specialization policy should target economic activities that have two key qualities: (i) they are achievable and hence "related" to the current strengths of a location; and (ii) they are more advanced or "complex" than the current set of economic activities. The underlying logic is that when deciding on location-based strategies, policy makers should target the most realistic innovations for a particular location. In this framework, high complexity economic activities provide the highest potential benefits; while relatedness is a proxy for risk. Activities that are highly related are considered low risk; activities that are unrelated are considered high risk. This is summarized very well in the Smart Specialization framework proposed by Balland et al, 2018 in figure 14:

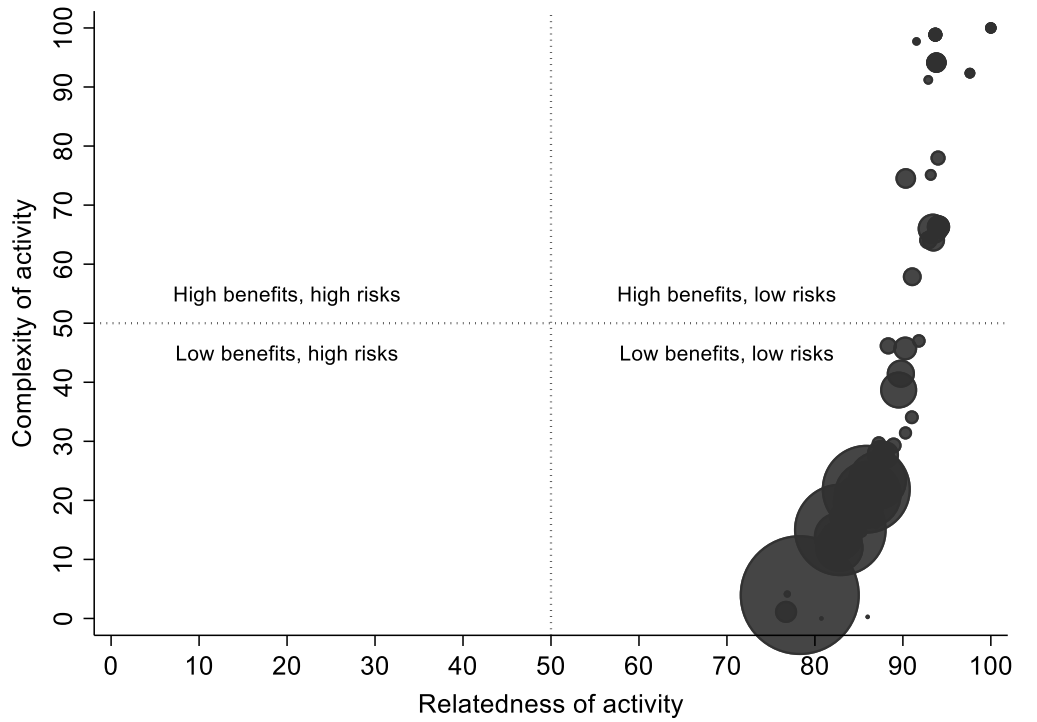
Figure 14: Smart Specialization Framework (Balland et al, 2018)[33]



We apply this smart specialization framework to the Rwandan context using data from the 2012 Census to measure both relatedness and complexity. This means that both the relatedness and complexity metrics are endogenous to the current capabilities of the Rwandan economy and that we will therefore not be able to identify new sectors of economic activity that Rwanda has yet to discover. We assume that Kigali is currently the frontier of innovation in Rwanda and that major new innovations will happen in Kigali first, not in Rwanda's secondary cities. Rather we ask the question: what activities that Kigali specializes in today, could other cities target in the future?

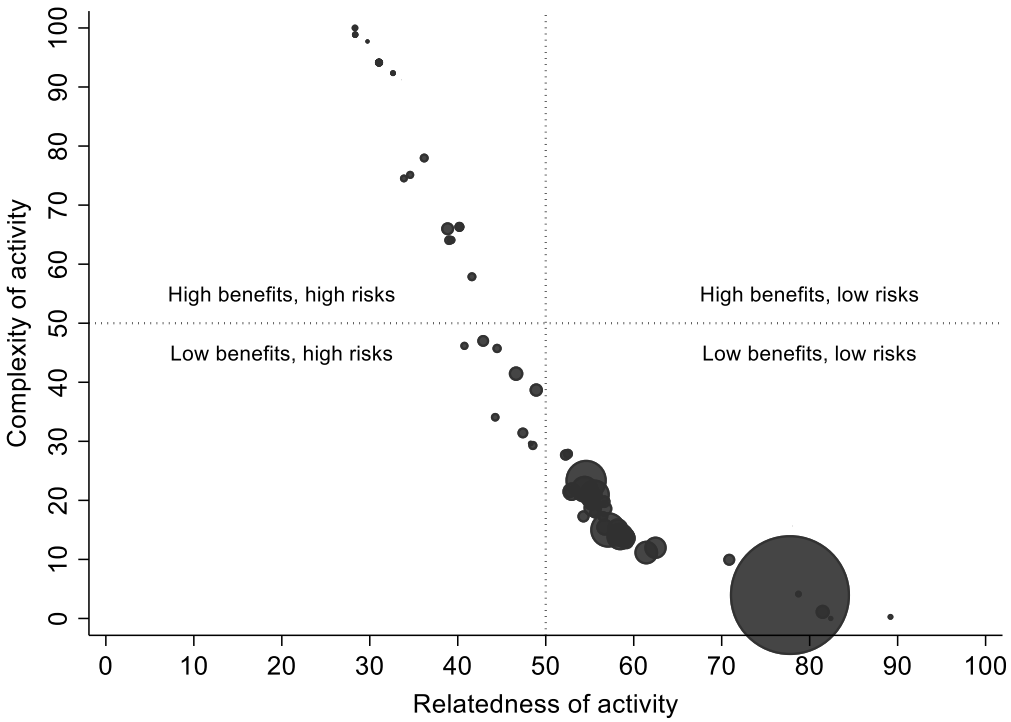
The analysis confirms that Kigali's Districts are at the frontier of innovation in Rwanda. Figure 15 reveals that economic activities with the highest complexity are also the ones that are the most related to Kigali (we use the example of Gasabo District). The y-axis in figure 15 measures the level of complexity of economic activities; the x-axis the relatedness of these activities to the economy of Gasabo District; and the size of the dots represent the proportion of the population that are employed in that activity. The District of Gasabo has many capabilities, which is reflected in the fact that its level of relatedness to "all activities" is high within the Rwandan context. This implies that investing in new and high complexity economic activities is relatively-speaking low risk (compared to Rwanda's other Districts). The majority of the working population of Gasabo District is still involved in low complexity activities, but as the size of the nodes reveals that the economy is diverse and that there is a relatively large proportion of the population working in high complexity activities.

Figure 15: Relatedness and complexity of economic activities for Gasabo District (economic activities at the ISIC 3 level)



The smart specialization picture is very different in the Districts of secondary cities, where the association between complexity and relatedness is reversed; all Districts outside of Kigali are more related to lower complexity activities than they are to high complexity activities. We highlight this with the example of Rubavu, which has the most advanced economy of Rwanda's Districts outside of Kigali. As can be seen in figure 16, the economy of Rubavu District in 2012 remained highly dominated by low complexity activities; there were no evident "wins" in terms of high benefits but low risks economic activities. At the District level any economic strategy that would target the development of a particular high-complexity economic activity, would be a "high-risk" endeavour, considering the existing capabilities in Rubavu District. Rubavu District could opt for what Balland et al (2018) refer to as a "slow road" policy, which would involve focusing on related but low-risk activities, moving only gradually to upgrade existing capabilities and invest in complex activities. As such, Rubavu's branding as "the international gateway city and tourism" does exactly that, enabling the District to gradually build on its strengths and not leap into more complex economic activities.

Figure 16: Relatedness and complexity of economic activities for Rubavu District (economic activities at the ISIC 3 level)



We obtain a slightly more nuanced picture when zooming in to specific Sectors within Districts. We highlight this with the cases of Gisenyi Sector in Rubavu, the most complex Sector outside of Kigali, and Muhoza Sector in Musanze District, the second most complex Sector outside of Kigali.

Gisenyi Sector in Rubavu, is the most complex Sector in Rubavu District; its economy is diverse and focused on both high and low complexity activities. In the upper right quadrant of the smart specialization framework 3 activities stand out as "high benefit and low risk activities" for this Sector. These include: (i) activities auxiliary to financial service activities, except insurance and pension funding; (ii) photographic activities; and (iii) travel agency and tour operator activities. Another economic activity that just enters this quadrant is the "manufacturing of fabricated metal products". These are activities that are already present in Gisenyi Sector, that are high-benefit Sectors that really fit the capability-mix of Gisenyi. One potential strategy for Gisenyi might be to strategically position itself to strengthen its specialization in these areas. At a very local level, Gisenyi has a pathway for a smart specialization policy. Balland et al (2018) refer to this as a "high-road" policy.

Figure 17: Relatedness and complexity of economic activities for Gisenyi Sector (economic activities at the ISIC 3 level)

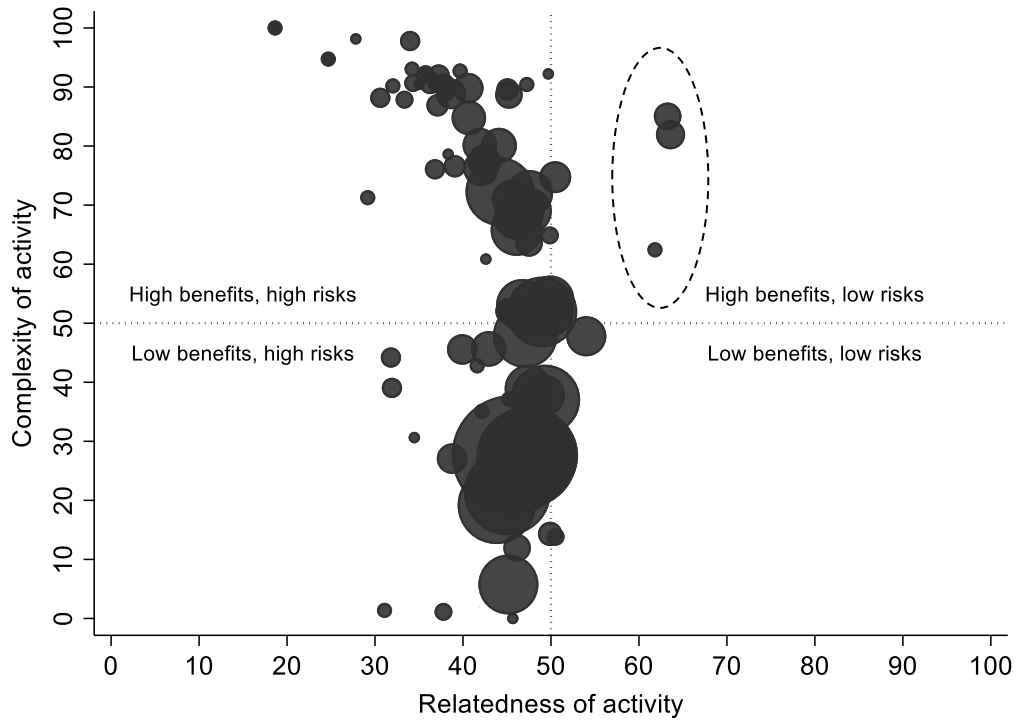
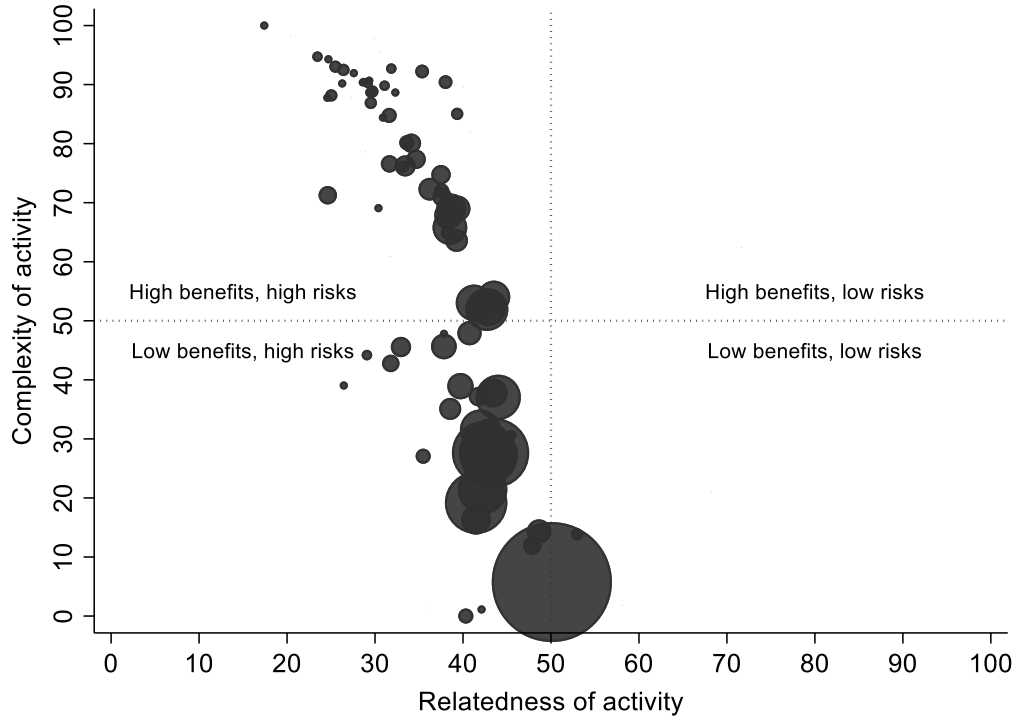


Figure 18: Relatedness and complexity of economic activities for Muhoza Sector (economic activities at the ISIC 3 level)



The case of Muhoza Sector in Musanze District is very different; while it is the Sector with the second highest level of economic complexity outside of Kigali, it remains dominated by low complexity activities, with no clear easy wins. This makes it very difficult to design a smart specialization strategy for Muhoza Sector. Its capabilities-base remains nascent and weak.

Muhoza doesn't also have a clear path towards implementing a "slow raod" policy, focusing on low complexity, but highly related activities. Any strategy that would focus on investing heavily in high-complexity activities in Muhoza Sector, would amount to a risky policy, either aiming to create a new sector of economic activity out of scratch or starting from a very low base. Balland et al, 2018, refer to this as the "casino policy" to regional specialization. Investing in economic activities in the bottom-left quadrant would be both risky with low potential returns, amounting to a "dead-end" policy (Balland et al, 2018).

Most urban Sectors outside of Kigali are in the same situation as Muhoza Sector, with no clear pathway for a smart specialization strategy.

This discussion raises a few insights for policy makers to consider:

- **Different types of economic development strategies are required for different types of regions**.
- **Most Districts and Sectors outside of Kigali might not yet have a sufficiently strong capabilities-base, making a sector-focused strategy "high-risks"**. This does not mean that a sector-focused approach would fail, but it does mean that a sector-specialization policy would involve risks, with a high probability of failure, but high rewards if the policy succeeds. For example investing in Muhanga as the city of the creative economy - which is not a sector that currently stands out for Muhanga - might succeed in kick-starting a creative industry in Muhanga, but such a strategy would not find a justification based on the current demand and capabilities of the city. While cities do currently have revealed comparative advantages in certain sectors - for example Huye in research and higher education, Muhanga in mining - this does not necessarily imply that these capabilities are strong enough to develop a vibrant economy around these sectors.
- **Considering that promoting a place-based policy targeting greater specialization in specific economic sectors of activity can be a high-risk strategy, it is important that a sector-focus not be the only central pillar of any spatial development policy.**

6. Regional internal trade

In this section we use EBM data to map internal trade in Rwanda for the first time. There is ample information on external trade. Each time a product is exported out of the country it is logged by product category and destination. The same is true for imports. However it is notoriously difficult to map internal trade within a country because there are no borders. Products and services are traded freely in Rwanda. In the informal economy, trade is by definition unobservable; in the formal economy, it is captured in the form of EBM receipts. In this section we map the flow of business-to-business transactions between locations at Sector-level.

One important definitional question is what we can consider to be "internal trade"? Do we base it on transactions between firms in different geographic Sectors, different Districts, or firms that are separated by a certain distance? When it comes to defining international trade it is a simple question; any transactions that cross the national border are classified as exports or imports. It is not as clear-cut when it comes to internal trade. How we define what internal trade is will affect the statistics and the picture we paint of internal trade in Rwanda. For the sake of this exercise we define as internal trade any transaction between firms in two different Districts of the country. We make an exception for the three Districts of Kigali (Nyarugenge, Gasabo and Kicukiro), which we consider to be one large and interconnected geographic unit. Any interactions between firms in Kigali's three Districts is not considered to be internal trade. We call "internal exporters" or simply "exporters" firms that sell products to firms in other Districts; we call "internal importers" or "importers", firms that buy products from other Districts.

Formal inter-District trade in Rwanda is estimated to be USD664m during the 2017 period compared against international exports of US$517m[34].

Before studying the details of internal trade, we first look at the role of geography in firm-to-firm transactions in the EBM data.

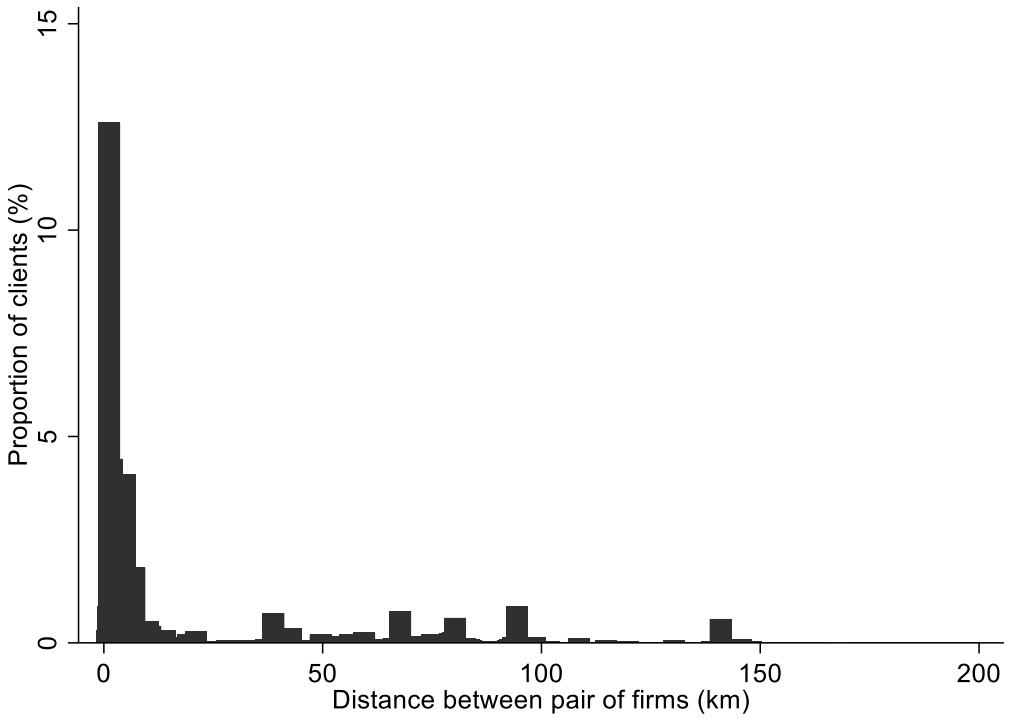
6.1. The role of geography in the firm-to-firm domestic trade network

The geographic distance between firms is a key determinant of how likely they are to trade (this holds true even when the location of the buyer is assigned differently, for example by using the place of registration of the firm, rather than the nearest EBM machine). We proxy for the distance between a pair of firms by calculating the distance between the centroids of the geographic Sectors they belong to[35]. We find that an estimated 25% of transactions are between firms that are within a radius of 2km from each other; 50% of transactions between firms that are within 4.3km from each other; and 75% of transactions between firms that are within 10km from each other.

[34]National Institute of Statistics of Rwanda, *Formal External Trade in Goods Report,* Quarter 4, 2017

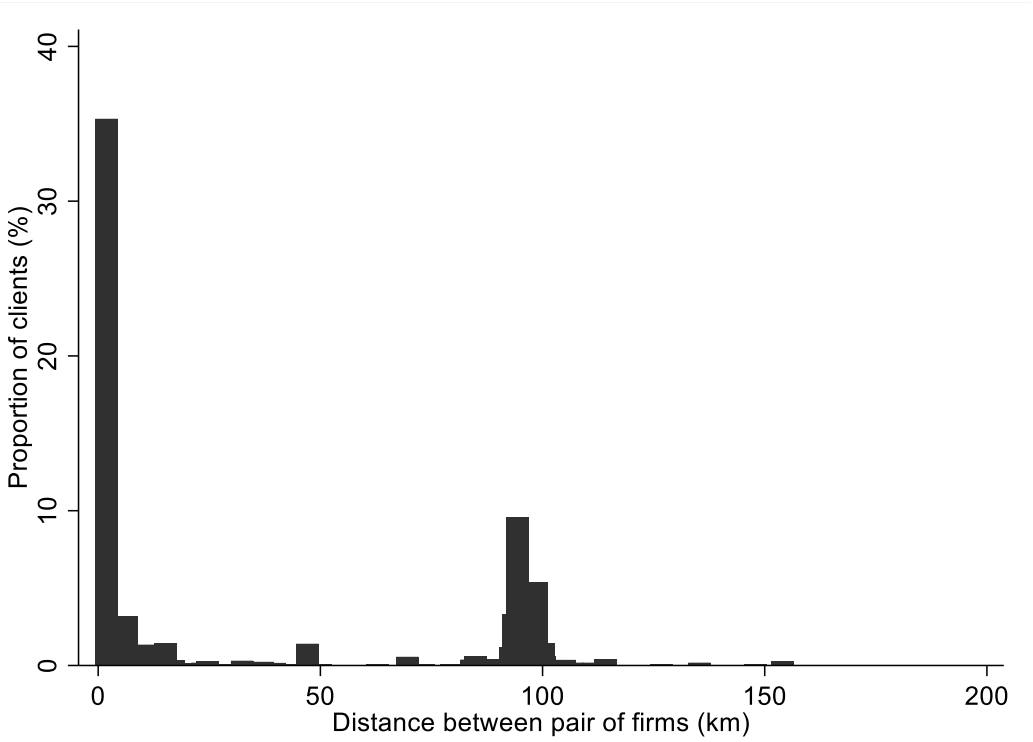
[35]For firms that are in the same geographic Sector we proxy for the distance between them using the radius of the geographic Sector they belong to; we assume for the sake of this exercise that the shape of the geographic Sector is relatively circular/.

Figure 19: Distribution of firm-to-firm trade, by distance between sellers and buyers in Rwanda



Given that Kigali accounts for a very large proportion of transactions, it is useful to visualize the association between distance and firm-to-firm transactions in the context of a different city. The example of Rubavu illustrates how geography shapes the domestic firm-to-firm network of Rwanda and why the association between transactions and distance is not monotonically decreasing. In Figure 20 we zoom in on suppliers in the city of Rubavu and look at the distribution of transactions, based on the distance between suppliers and buyers. This histogram shows that distance matters and that firms in Rubavu are most likely to sell to other firms that are nearby. The figure also shows that for firms in Rubavu a high proportion of their buyers are based in Kigali, which is about 100km away. This explains the high concentration of sales around the 100km mark. We observe a similar pattern for firms located in other cities of the country, highlighting the important role of proximity and the role of Kigali as the main hub of Rwanda's economy.

Figure 20: Distribution of firm-to-firm trade for suppliers located in Rubavu, by distance between sellers and buyers



Firms in different areas of economic activity have a different propensity to trade with firms in other locations. All sectors of the economy participate in domestic trade, but certain industries more than others. We show this by looking at the geographic distribution of the clients of firms in different sectors of economic activity (see One of **the key determinants of the propensity of firms to sell to buyers in other parts of the country is the size of the local market (in terms of the number of firms).** Firms that are located in areas where the local market is large - in relative terms – have a higher proportion of clients in their immediate vicinity; firms that are located in areas where the local market is small, are more likely to have a greater proportion of their clients in further away locations. An estimated 89% of the clients of firms in Gasabo, 87% in Kicukiro and 79% in Nyargugenge – the three Districts of Kigali – were located within a 15km radius of the supplier. This number is significantly lower for firms in and around other towns. In Huye District for example, 48% of the buyers were located within a 15km radius of the supplier; in Ruvabu this number was 46%; in Rusizi 36%; in Muhanga 35%; in Nyagatare 21%. Firms that are located in cities other than Kigali are more likely to have look for buyers and markets outside of the boundaries of their cities.

Table 19). We see that real estate is the most “localized” industry. More than 90% of the clients of firms in the real-estate sector were located within a 15km radius from the supplier. This is consistent with the fact that real-estate is typically considered a “non-tradables” sector, that relies very heavily on local knowledge of the real estate market. Firms in the agriculture, manufacturing and food and accommodation industries are the most likely to transact with companies in other parts of the country.

One of the key determinants of the propensity of firms to sell to buyers in other parts of the country is the size of the local market (in terms of the number of firms). Firms that are located in areas where the local market is large - in relative terms – have a higher proportion of clients in their immediate vicinity; firms that are located in areas where the local market is small, are more likely to have a greater proportion of their clients in further away locations. An estimated 89% of the clients of firms in Gasabo, 87% in Kicukiro and 79% in Nyargugenge – the three Districts of Kigali – were located within a 15km radius of the supplier. This number is significantly lower for firms in and around other towns. In Huye District for example, 48% of the buyers were located within a 15km radius of the supplier; in Ruvabu this number was 46%; in Rusizi 36%; in Muhanga 35%; in Nyagatare 21%. Firms that are located in cities other than Kigali are more likely to have look for buyers and markets outside of the boundaries of their cities.

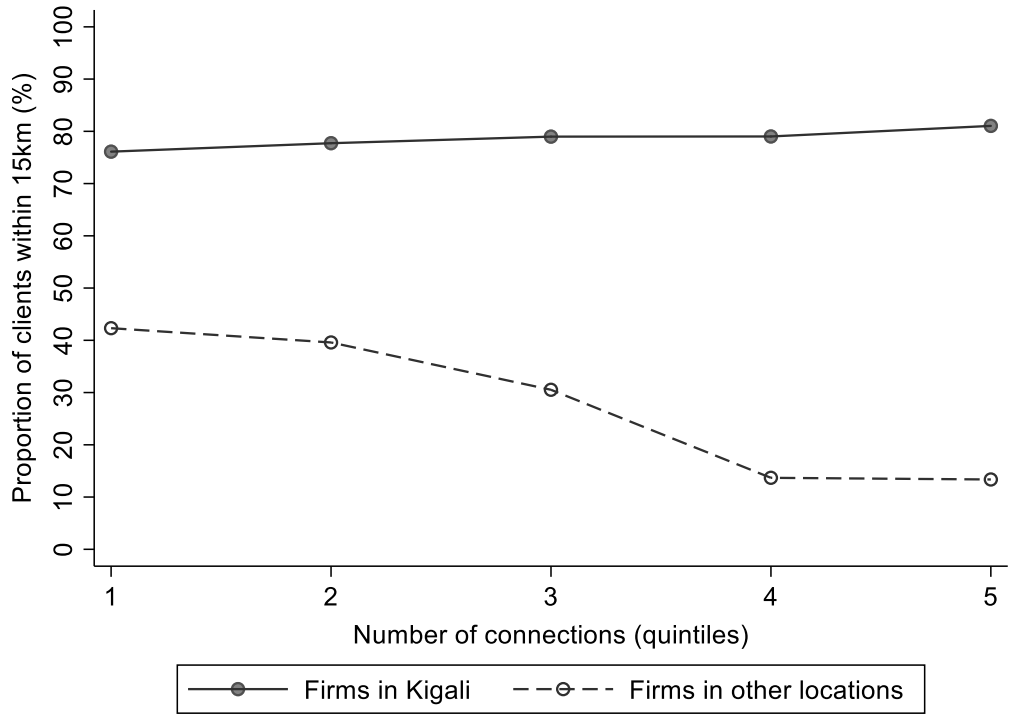
Table 19: Percentage of sales made to buyers within 15km, by area of economic activity of the buyer

ISIC description of firm at registration	Proportion of clients within 15km radius
Real estate activities	90.4%
Construction	86.0%
Professional, scientific and technical activities	83.9%
Water supply; sewerage, waste management and remediation activities	83.7%
Human health and social work activities	83.4%
Transportation and storage	82.9%
Information and communication	82.8%
Arts, entertainment and recreation	81.4%
Wholesale and retail trade; repair of motor vehicles and motorcycles	78.9%
Other service activities	78.7%
Education	78.6%
Administrative and support service activities	77.6%
Mining and quarrying	76.6%
Financial and insurance activities	75.0%
Electricity, gas, steam and air conditioning supply	74.8%
Manufacturing	74.4%
Agriculture, forestry and fishing	70.3%
Accommodation and food service activities	64.9%

The size of firms - proxied for here by the number of connections they have in the firm-to-firm network - also determines how likely firms are to participate in domestic regional trade; there are clear differences between firms in Kigali and other locations. First of all, it is important to note that firms of all sizes participate in regional trade, not only the largest and most connected firms. In Kigali, less connected firms are in fact slightly more likely to trade with firms in other locations (see Figure 21). The situation is very different for firms outside of Kigali. The more connected a firm outside of Kigali, the more likely it is to participate in domestic regional trade and to find its clients in other locations. The most connected firms outside of Kigali have about 90% of their clients in other locations (more than 15km away). Smaller firms are more local, with about 42% of their clients located within a

15km radius, and 58% of their clients in other locations. But even the smallest/least connected firms located outside of Kigali have more clients in other locations than in their immediate vicinity. This suggests that the size of the domestic market might be a key constraint to firm growth in locations outside of the capital.

Figure 21: Proportion of corporate clients with 15km, by number of connections and locations



6.2. Regional internal trade

Inter-District exports are driven by internal exporters located in urban areas; the distribution of inter-District imports is slightly more balanced between urban and rural areas. We define as urban any geographic Sector with a population in 2012 of more than 870 people per capita (which allowing for a projected population growth rate of about 2.8% per annum would correspond to a population of 1,000 people per capita in 2017); or any Sector belonging to the official delineations of Rubavu, Musanze, Muhanga, Huye, Rusizi, Nyagatare, Byumba, Rwamagana, Kayonza and Nyamata. We are obliged to use a proxy since official definitions of urban/rural locations are established at the village level and the smallest geographic unit we work with are Sectors. Using this definition, we find that urban-urban trade makes up about 60% of EBM trade in the country; urban-to-rural links explain almost 40% of trade; rural-to-rural trade represents only about 1.1% of economic transactions. About 92% of exports in the domestic trade network originated in urban areas; this compares to about 66%

of imports, which shows that in general terms trade flows form urban areas of the country to rural areas.

Table 20: Distribution of internal trade, by urban and rural buyers and suppliers

	Urban - *supplier*	Rural - *supplier*	Totals by buyer
Urban - *buyer*	59.6%	6.6%	**66.2%**
Rural - *buyer*	32.7%	1.1%	**33.8%**
Totals by supplier	**92.3%**	**7.7%**	**100%**

Zooming-in to the case of EBM trade between urban areas of Rwanda – which in 2017 amounted to about US$400m - we observe that trade flows from Kigali towards other cities. An estimated 78% of internal exports involving two firms located in different urban areas of the country originated in Kigali. The remaining 22% of exports of the urban trade network originated in other cities. About four fifths of these exports were destined to Kigali (82%) and one fifth (18%) to other towns. With 78% internal exports originating in Kigali, compared to just 18% of imports, the data confirms that the direction of internal trade flows from the capital to other cities and towns in Rwanda.

Table 21: Distribution of internal trade between urban areas

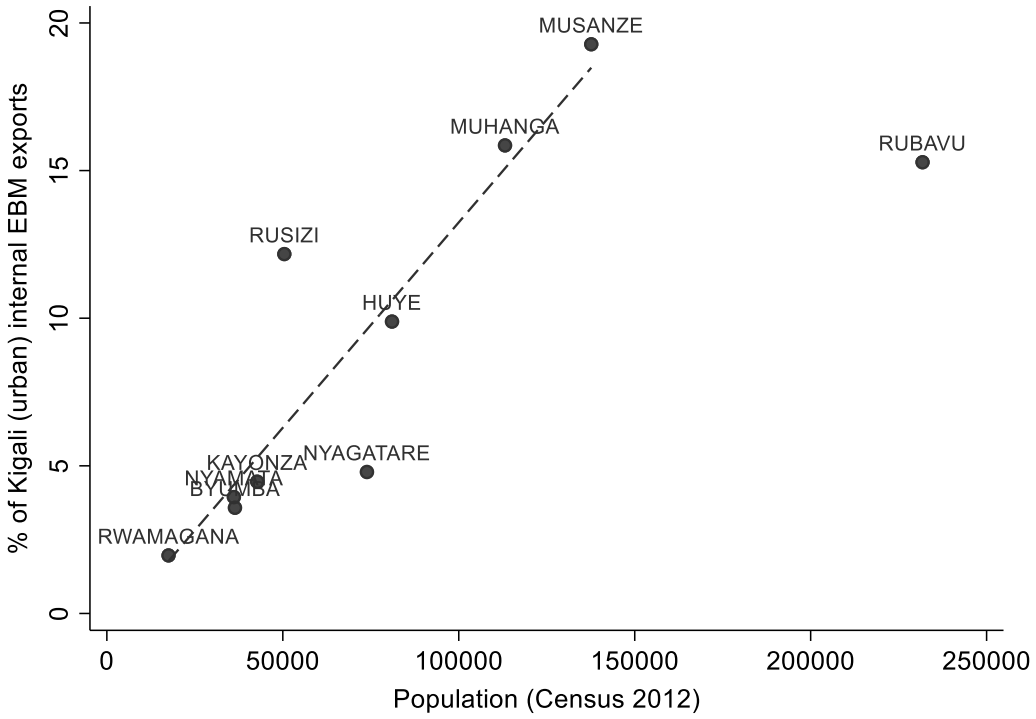
	Kigali - *supplier*	Other city- *supplier*	Totals by buyer
Kigali - *buyer*	-	18.2%	**18.2%**
Other city - *buyer*	77.7%	4.1%	**81.8%**
Totals by supplier	**77.7%**	**22.3%**	**100%**

Kigali's largest export destinations are Musanze, Muhanga and Rubavu. More than 50% of Kigali's exports to other urban destinations went to these three cities alone (amounting to approximately US$150m in exports to these cities during the 2017 period). Table 22 shows that there are quite large discrepancies between cities in terms of the level of imports they receive from Kigali. These discrepancies appear to be explained by differences in their population levels (see Figure 22), which is a good proxy for the size of the domestic market of these cities. Rubavu is a clear outlier. Given Rubavu's population levels, we would have expected the city to attract a much larger share of domestic exports from Kigali. Again Goma appears as a city with a high potential for growth and better trade connections with Kigali.

Table 22: Destination of urban internal exports originating from Kigali

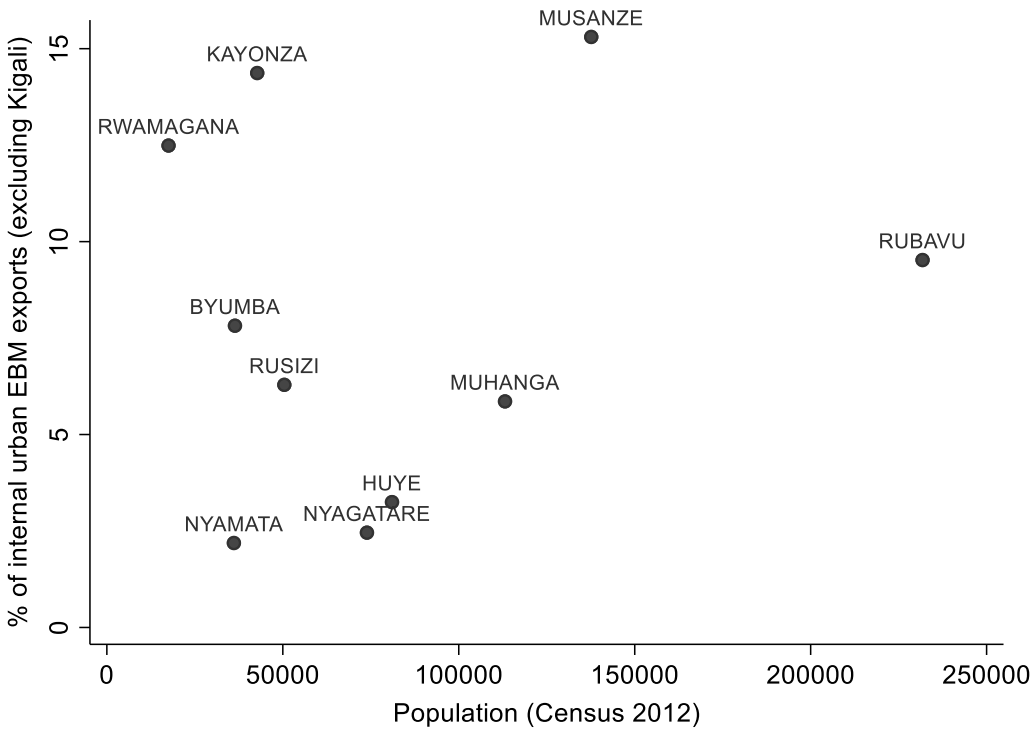
Destination	% of Kigali exports to other cities (excluding rural locations)
Musanze	19.3%
Muhanga	15.9%
Rubavu	15.3%
Rusizi	12.2%
Huye	9.9%
Nyagatare	4.8%
Kayonza	4.5%
Nyamata	3.9%
Byumba	3.6%
Rwamagana	2.0%
Other towns	8.8%

Figure 22: Distribution of internal urban exports from Kigali to other cities in Rwanda (2017) versus estimated City population levels (2012)



The most active internal exporters outside of Kigali were Musanze (15% of exports originating from other cities), Kayonza (14%) and Rwamagana (12%). In 2017, internal exports originating in cities outside of Kigali contributed to an estimated US$88m in trade in the EBM data**.** The contributions of Kayonza and Rwamagana to the export market is surprising considering the small size of these cities. These two cities together, contributed as much to internal exports as Rubavu (10%), Rusizi (6%) and Muhanga (6%) combined. Population levels are a good proxy for the market size of cities, but they are not good predictors of the contribution of cities to Rwanda's export market. One potential explanation, which we explore further later in this report, is that proximity to Kigali – or other urban centres – plays a major role.

Figure 23: Distribution of internal urban exports originating in cities other than Kigali (2017) versus estimated City population levels (2012)



Firms in secondary cities and other emerging towns of Rwanda look for clients in Kigali; other city-to-city export routes are very small. Kigali is the top export destination for all major cities of Rwanda, including Musanze, Rubavu, Huye, Rusizi, Muhanga, Nyagatare, Rwamagana, Kayonza, Byumba and Nyamata. The strongest export links between cities and Kigali are with Musanze and towns in the East, including Rwamagana, Kayonza and Byumba. The two largest trade links between two cities outside of Kigali involved the Rubavu-Musanze link, along the "Virunga Belt", and the Rubavu-Rusizi axes, along the "Kivu Belt". While these are the strongest trade links between secondary cities in Rwanda, they only account for a small proportion of total internal trade. To give the reader a sense of scale, we estimate that EBM transactions between firms in Rubavu and Musanze in 2017 amounted to approximately US$2.2m. Using EBM data, we cannot conclude on the existence of alternative trade corridors, other than the key axes linking cities to Kigali.

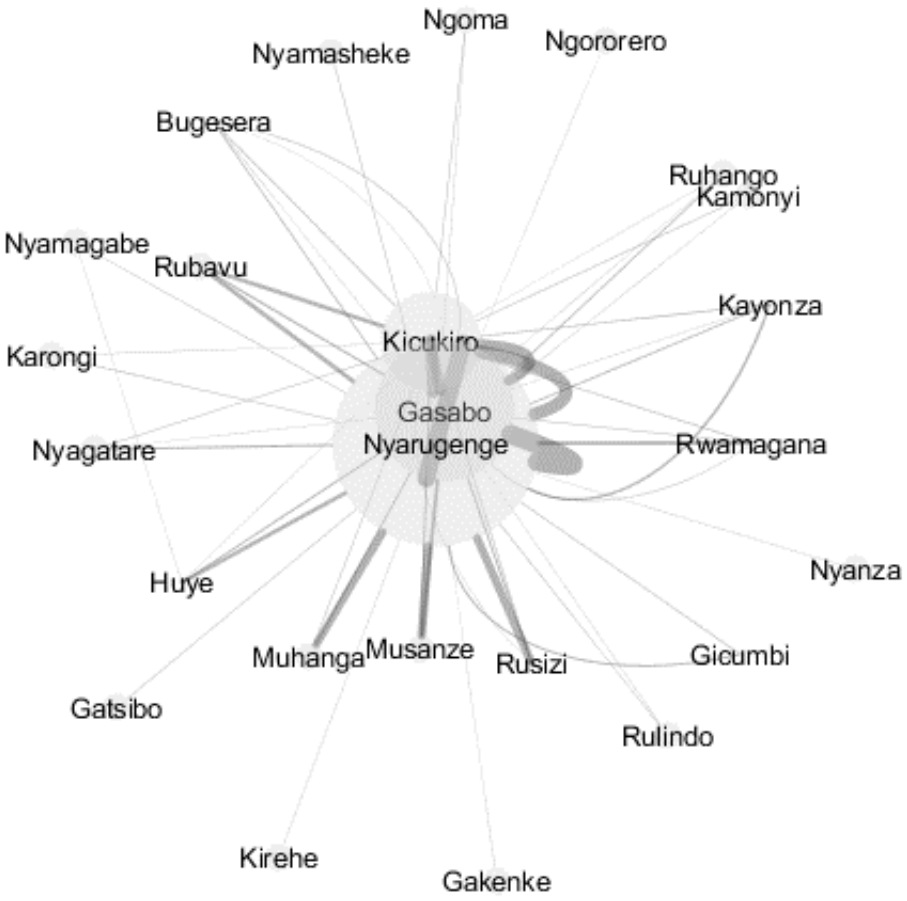
Table 23: EBM exports between pairs of cities (where trade originates outside of Kigali)

Rank	Internal exporter	Internal importer	Proportion of total exports originating in cities outside Kigali
1	ALL OTHER TOWNS	KIGALI	14.9%
2	MUSANZE	KIGALI	12.5%
3	RWAMAGANA	KIGALI	12.4%
4	KAYONZA	KIGALI	11.9%

5	BYUMBA	KIGALI	7.4%
6	RUBAVU	KIGALI	6.1%
7	RUSIZI	KIGALI	5.4%
8	MUHANGA	KIGALI	4.6%
9	HUYE	KIGALI	3.0%
10	NYAMATA	KIGALI	2.1%
11	ALL OTHER TOWNS	MUHANGA	1.9%
12	RUBAVU	RUSIZI	1.6%
13	NYAGATARE	KIGALI	1.4%
14	MUSANZE	RUBAVU	1.4%
15	ALL OTHER TOWNS	RUBAVU	1.3%
16	RUBAVU	MUSANZE	1.1%
17	MUHANGA	HUYE	1.0%
18	ALL OTHER TOWNS	KAYONZA	0.9%
19	KAYONZA	MUHANGA	0.8%
20	ALL OTHER TOWNS	MUSANZE	0.6%

It is possible to visualize Rwanda's internal trade system using a network visualization. This network confirms that Kigali is at the very centre of Rwanda's internal trade system and that there are few connections linking other parts of the country together directly (see Figure 24). For the simplicity of this visualization we focus on aggregate trade between pairs of Districts, thereby making the network undirected. Since all Districts have a negative trade balance with Nyarugenge, this does not change much to the visualization.

Figure 24: Undirected network representation of District-to-District trade (only links above RWF5bn represented – size of edge proportional to trade between two Districts; size of node proportional to total trade by District)



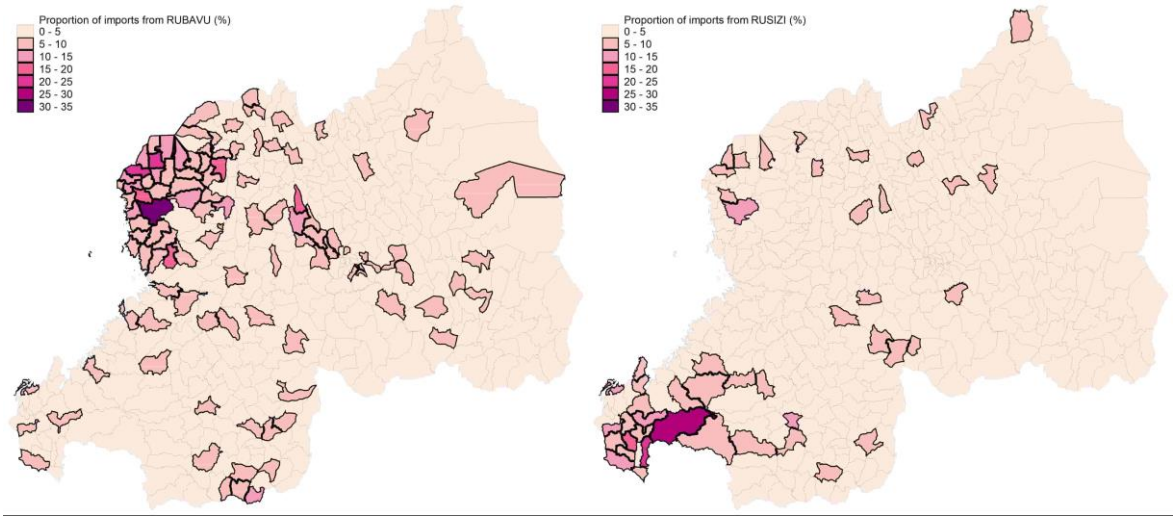
6.3. Patterns of trade at the local level

Rwanda's internal trade network is hierarchically structured: (i) at the national-level, Kigali acts as the central hub, connecting different parts of the country together; (ii) at the local level, we find that this role is also played – to some extent - by other cities. To study trade at the local level we move from a focus on District-to-District transactions, to transactions between firms in different geographic Sectors. This allows us to visualize trade at a more granular level. We can learn about the economic footprint of cities on their surroundings, by looking at whether firms in surrounding geographic Sectors import a lot of products and services from those cities. To do this we calculate what proportion of the EBM imports in Sectors come from the city we are studying. We visually compare the cases of Rubavu and Rusizi using two maps, each representing the proportion internal imports at the Sector level that come from either of these cities (see Figure 25). These two examples were selected because they are located in different parts of the country; the same insights hold true for other cities.

These two cases illustrate three important points: (i) cities exert a clear influence on their local surroundings; (ii) the outreach of cities is quite expansive, with connections not only in nearby-Sectors, but also in other parts of the country; and finally (iii) the importance of cities on their surroundings could be much stronger. The geographic pattern of influence is different for each city. Rubavu plays an important role as a supplier for Sectors in the Western part of the country and all

along the Kivu belt; Rusizi in the South West of the country. The geographic zone of influence of these cities is quite large. Firms in each of these towns have connections across the country, not only in their immediate surroundings or with buyers located in Kigali. However, even at the most local level, firms in the "receipted economy" tend to import more from Kigali than from neighbouring towns and cities. The maximum influence Rubavu exerts on the imports of a Sector is 33% of imports in that Sector; for Rusizi the maximum is 28%. Of course EBM data underestimates actual interconnections at the local level – most of which are informal - but strengthening value chains and ties at the most local level, connecting firms in the vicinity of cities to the formal trade networks of these cities, is an area where easy gains can be made.

Figure 25: Proportion of imports from Rubavu (left) and Rusizi (right), by Sector



6.4. A gravity model to predict internal regional trade

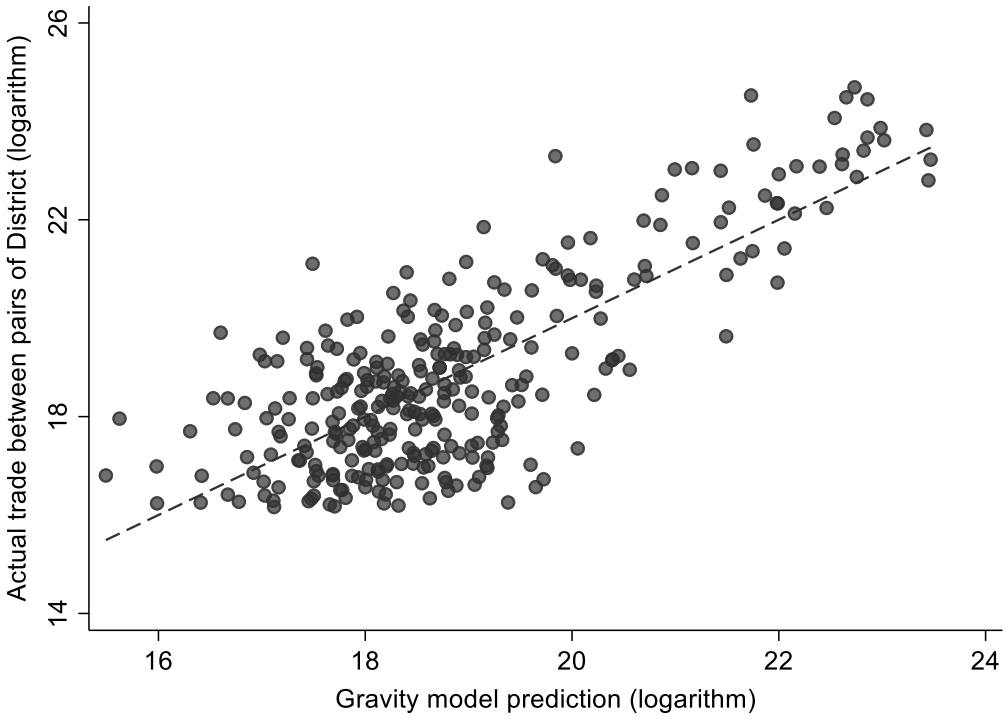
In this section we use a slight adaptation of the gravity model to predict trade flows between cities in Rwanda and discuss some of the insights we can derive from that model. We have seen that population levels play an important role in predicting the level of exports from Kigali to other cities in the country, but that the population of cities is not a very good predictor of the level of their exports to other locations of the country. This is because trade depends on a number of structural parameters, beyond simply the size of the city or location where the trade originates. At minimum, the level of trade between two locations, depends on the demographic and economic situation of the city where trade originates, the demographic and economic situation of the recipient city or location and the geographic distance and connectivity between the two locations. A famous, simple and very sensible model, called the gravity model (see Ravenstein, 1885; Isard, 1954; Haynes and Fotheringham, 1984), predicts that flows between two locations – for example economic flows, migration or traffic - are a function of the respective sizes of the two locations and the distance between them. It is called the gravity model because its formulation is similar to that of Newton's law of gravitation. The underlying principles of the model are that the flows between two locations are: (i) directly proportional to the sizes and masses of the two locations; and (ii) indirectly proportional to the distance that separates them (Todd, 2010).

We adapt a gravity model to describe export flows between Districts in Rwanda, using District population (based on Census 2012 figures) as an indicator of the size of the respective locations, and distance expressed in kilometres as a measure of the degree of separation between Districts. The parameters of this model are estimated using a simple log-log regression applied only to District-to-District trade links involving more than Rwf 10m in trade (approximately US$11,765 in 2017 terms); we select an arbitrary minimum threshold to eliminate District-to-District trade links that are insignificant and that rely on too few transactions to obtain accurate predictions. This log-log regression includes the logarithm of actual exports between all pairs of exporting and importing Districts as the dependent; the explanatory variables include the logarithm of the population of both the exporting and the importing District, as well as the logarithm of the geographic distance separating them. We use the predictions of this log-log regression as our gravity estimator. The predictions are directed, meaning we can distinguish between exports and imports.

This model works very well and explains about 60% of internal trade between pairs of Districts in Rwanda's EBM network (focusing only on connections that meet the minimum trade threshold). A comparison of the predictions of the model and the registered level of EBM trade between two locations is presented in

Figure 26. We can see a very linear association between the predictions of the gravity model and the level of actual trade between pairs of Districts, taking into account both imports and exports. Further analysis will be needed to understand what explains deviations from the gravity model, but one factor that clearly stands out is the internal road connectivity of both pairs of Districts.

Figure 26: Predictions of gravity model versus actual trade flows between pairs of Districts



Models provide us with a benchmark to compare reality against.

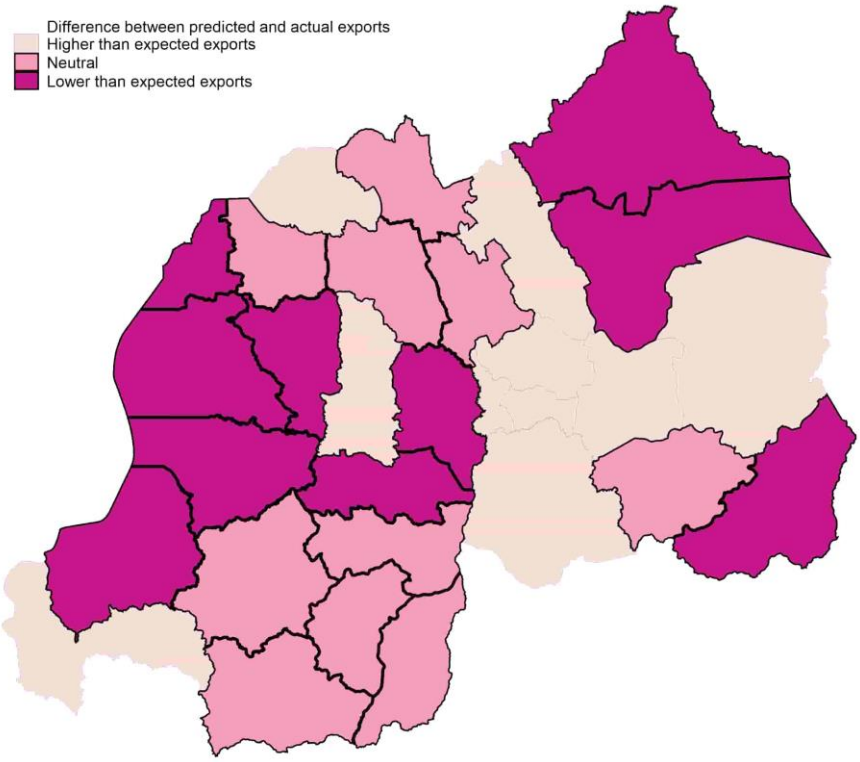
Deviations from the predictions of this gravity model are interesting to study and could help us identify trade links that are under or over-performing. To study deviations from the model, we simply compare model predictions to actuals. The difference between the model predictions and the actuals can be thought of as a measure of the latent potential for a particular District or trade-link of interest. We caution the reader that the latent potential we estimate here only takes into account the respective population of two locations and the distance between them. Although these are key determinants of trade, there are however innumerable other factors that matter and that might explain differences in exports per District or District pair that we are not able to consider here.

Our predictions suggest that Kigali and Rusizi represent a much larger share of internal exports than we would expect, while Districts such as Nyamasheke, Gatsibo, Nyatarare Kamonyi, Rubavu and Karongi are under-represented in the EBM data. If Rwanda's economy were to converge to the values predicted by the gravity model, we would expect the weight of Kigali in the domestic export sector to reduce from the current 75.2% of all EBM exports, to an estimated 67.1% of exports (see Table 24). Kigali would continue to be the dominant force in Rwanda's trade sector, but less so than it is today. The economic footprint of Rusizi on domestic trade would also reduce, from the current 3.6% of domestic exports, to about 0.7% exports. The Districts that would experience the biggest increase are along the "Kivu Belt", from Rubavu, through to Karongi and Nyamasheke; on the centre axes of the country (Rutsiro, Kamonyi); and in the North East (Nyagatare and Gatsibo). Given their strategic locations and the size of their populations, the potential for growth would be the highest in Nyamashake, Gatsibo and Nyagatare. Out of Rwanda's secondary cities, Rubavu and Nyagatare appear to be Rwanda's two cities with the highest latent potential for domestic export growth.

Table 24: Difference between current and predicted proportion of domestic exports, by District

Rank	District	Current proportion of internal exports	Predicted proportion of internal exports	Percentage point difference (expected-actual)
1	Nyamasheke	0.1%	3.4%	3.26
2	Gatsibo	0.3%	2.8%	2.45
3	Nyagatare	0.7%	2.7%	2.00
4	Kamonyi	0.5%	2.0%	1.53
5	Rubavu	1.6%	3.1%	1.47
6	Karongi	0.3%	1.3%	1.02
7	Rutsiro	0.0%	0.7%	0.67
8	Ruhango	0.4%	1.0%	0.65
9	Kirehe	0.4%	1.0%	0.60
10	Ngororero	0.0%	0.3%	0.25
11	Gisagara	0.2%	0.4%	0.23
12	Nyamagabe	0.5%	0.7%	0.16
13	Burera	0.0%	0.2%	0.13
14	Nyanza	0.3%	0.4%	0.10
15	Nyaruguru	0.1%	0.2%	0.09
16	Gakenke	0.1%	0.2%	0.08
17	Nyabihu	0.0%	0.1%	0.07
18	Ngoma	0.3%	0.4%	0.05
19	Huye	1.5%	1.5%	0.00
20	Rulindo	0.5%	0.5%	-0.01
21	Gicumbi	1.3%	1.1%	-0.18
22	Kayonza	2.5%	2.2%	-0.33
23	Muhanga	1.4%	1.0%	-0.36
24	Musanze	2.7%	2.0%	-0.75
25	Bugesera	2.0%	1.0%	-1.03
26	Rwamagana	3.4%	2.3%	-1.14
27	Rusizi	3.6%	0.7%	-2.94
28	Kigali	75.2%	67.1%	-8.06

Figure 27: Map representing difference between expected and actual EBM exports



We can take this analysis one step further and look at the trade routes with the highest latent potential. We study this from the perspective of key cities, proxied for here by their Districts. We present a series of tables for each District in which a city is located and compare the current destination-mix to the theoretic mix we would expect to observe on the basis of the gravity model. Key patterns coming out of this analysis include the following facts: (i) current exports from cities other than the capital are non-diverse in terms of their export destinations and highly dominated by Kigali; (ii) the gravity model, predicts an increasing diversification of the exports for secondary cities; (iii) each secondary city has an idiosyncratic mix of high-potential trading partners; and (iv) the model predicts the rise of Nyamasheke as a key future export destination for many secondary cities.

Despite having such a high potential due its strategic location and population, there is currently very little urban infrastructure in Nyamasheke District, with only small towns such as Kirambo and Kagano lining up along the newly opened highway connecting Karongi to Rusizi. Nyamasheke has very low connectivity, with a low concentration of feeder roads leading to the asphalted road. It is also blocked in the East by Nyungwe Forest. While there is a highway through Nyungwe Forest to the South of Nyamasheke, there is no main road circumventing the park from the North, which would allow Nyamasheke to connect to cities on the Huye-Kigali highway, such as Nyanza for example. Given its strategic potential, investments in upgrading the infrastructure and connectivity of Nyamasheke might yield high returns for the Rwandan economy.

The District of Rubavu

Currently an estimated 50% of exports from Rubavu are destined to Kigali. We would expect the share of Kigali to decrease in the future, and a much greater share of exports to be explained by trade with the nearby districts of Nyamasheke and Karongi. Rubavu currently has almost no trade with most of these high-potential destinations.

Table 25: Difference between current and predicted proportion of domestic exports for Rubavu

Importer	Current proportion of internal exports	Predicted proportion of internal exports	Percentage point difference (expected-actual)
Kigali	50.8%	27.3%	-23.5
Rutsiro	10.4%	7.6%	-2.8
Musanze	9.2%	7.5%	-1.7
Nyamasheke	0.4%	6.3%	5.9
Karongi	0.2%	4.6%	4.3
Nyagatare	0.1%	3.7%	3.6
Gatsibo	1.0%	3.6%	2.6
Kamonyi	0.9%	3.1%	2.2
Ngororero	0.6%	3.0%	2.4
Muhanga	1.1%	2.7%	1.6

The District of Musanze

Kigali currently imports an estimated two thirds of exports originating from Musanze. We expect that number to drop significantly in the future and for trade to increase significantly with Rubavu, Nyagatare, Gatsibo and Nyamasheke. Musanze currently has very little trade with key potential partner Districts.

Table 26: Difference between current and predicted proportion of domestic exports for Musanze

Importer	Current proportion of internal exports	Predicted proportion of internal exports	Percentage point difference (expected-actual)
Kigali	66.8%	29.9%	-36.8
Rubavu	7.5%	9.0%	1.5
Nyagatare	0.3%	4.8%	4.5
Gatsibo	0.3%	4.4%	4.1
Nyamasheke	0.2%	4.1%	3.9
Kamonyi	1.0%	3.4%	2.4
Gicumbi	0.5%	3.1%	2.6
Rutsiro	1.1%	3.1%	2.0
Gakenke	1.7%	3.0%	1.3
Nyabihu	7.0%	2.9%	-4.2

The District of Muhanga

Muhanga's main export destinations are currently Kigali, Huye and Karongi. We would the weight of both Kigali and Huye in Muhanga's export-mix to decrease significantly in the future, and to be replaced by exports to Kamonyi, Ruhango, Nyamasheke and Rubavu.

Table 27: Difference between current and predicted proportion of domestic exports for Muhanga

Importer	Current proportion of internal exports	Predicted proportion of internal exports	Percentage point difference (expected-actual)
Kigali	45.2%	36.1%	-9.1
Kamonyi	1.4%	6.9%	5.5
Ruhango	5.4%	5.9%	0.4
Nyamasheke	2.1%	4.2%	2.1
Rubavu	0.6%	4.0%	3.3
Karongi	8.9%	3.8%	-5.1
Huye	10.4%	3.2%	-7.2
Gatsibo	0.0%	3.0%	3.0
Musanze	1.2%	2.9%	1.7
Nyagatare	0.0%	2.7%	2.7

The District of Huye

Kigali accounts for a lower proportion of Huye's exports destination-mix than other secondary cities, but we nevertheless expect the weight of Kigali to decrease significantly in the future. Huye's other very large trading partners today include Gisagara and Nyamagabe. We expect that their contribution to Huye's export-mix will also be reduced in the future. The gravity model predicts that Huye will diversify its exports to destinations such as Nyamasheke, Ruhango, Rubavu and Nyaruguru.

Table 28: Difference between current and predicted proportion of domestic exports for Huye

Importer	Current proportion of internal exports	Predicted proportion of internal exports	Percentage point difference (expected-actual)
Kigali	37.7%	28.5%	-9.2
Gisagara	16.6%	10.0%	-6.6
Nyamasheke	0.6%	5.9%	5.3
Nyamagabe	36.1%	5.2%	-30.9
Ruhango	0.1%	4.2%	4.1
Rubavu	0.4%	4.1%	3.7
Nyaruguru	2.7%	4.0%	1.3
Nyanza	1.5%	3.5%	2.1
Karongi	0.1%	3.4%	3.3
Muhanga	1.3%	2.9%	1.6

The District of Rusizi

Rusizi is another town that relies too heavily on Kigali for its export destinations. We predict that Kigali will weigh less on Rusizi's export destination mix in the future and that Nyamasheke District will become one of the main export destinations for Rusizi. The model predicts that Nyamasheke has the potential to be on par with Kigali as a potential export destination for products and services from Rusizi.

Table 29: Difference between current and predicted proportion of domestic exports for Rusizi

Importer	Current proportion of internal exports	Predicted proportion of internal exports	Percentage point difference (expected-actual)
Kigali	63.8%	22.8%	-41.0
Nyamasheke	7.8%	20.2%	12.4
Rubavu	6.0%	5.4%	-0.6
Karongi	1.6%	4.5%	2.9
Huye	1.0%	4.0%	3.1
Nyamagabe	0.4%	3.4%	3.0
Musanze	2.3%	3.1%	0.8
Gatsibo	0.7%	3.0%	2.3
Rutsiro	0.2%	2.8%	2.7
Nyagatare	1.3%	2.8%	1.5

The District of Nyagatare

Nyagatare is expected to strengthen its export ties with the neighbouring Districts of Gatsibo and Gicumbi and the nearby District of Kamonyi. Kigali, Rubavu and Kayonza, are predicted to be less dominant in Nyagatare's exports mix in the future.

Table 30: Difference between current and predicted proportion of domestic exports for Nyagatare

Importer	Current proportion of internal exports	Predicted proportion of internal exports	Percentage point difference (expected-actual)
Kigali	43.4%	35.2%	-8.2
Gatsibo	5.6%	10.2%	4.6
Kayonza	7.1%	4.7%	-2.5
Gicumbi	0.0%	4.6%	4.5
Rwamagana	3.9%	4.4%	0.5
Musanze	0.2%	4.3%	4.0
Rubavu	8.4%	3.8%	-4.6
Kamonyi	0.2%	3.6%	3.4
Nyamasheke	0.0%	3.4%	3.4
Kirehe	0.1%	2.5%	2.4

The City of Kigali

Kigali's current export destinations are diverse, but are dominated by Rwanda's secondary cities, including Musanze (12% of exports), Rusizi (11% of exports) and Rubavu (10% of exports). The gravity model predicts a complete re-ordering of historic export ties, with a much greater focus on neighbouring Districts, including Kamonyi, Gatsibo, Rwamagana, to the north Gicumbi and Nyagatare and to the South Bugesera. As these areas of the country grow in population size and urbanize, the geographic focus of Kigali is poised to refocus on trade with areas in the eastern half of the country.

Table 31: Difference between current and predicted proportion of domestic exports for Kigali

Importer	Current proportion of internal exports	Predicted proportion of internal exports	Percentage point difference (expected-actual)
Kamonyi	2.9%	8.8%	5.9
Gatsibo	1.9%	8.6%	6.7
Rwamagana	5.2%	8.4%	3.2
Nyagatare	4.2%	5.6%	1.4
Kayonza	5.5%	5.4%	0.0
Bugesera	4.5%	4.8%	0.3
Rubavu	9.7%	4.8%	-5.0
Gicumbi	3.4%	4.6%	1.2
Nyamasheke	2.0%	4.3%	2.3
Musanze	12.5%	4.2%	-8.2

6.5. Infrastructure connectivity

We find that the density of road intersections within both the supplier and client Distircts are positively associated with trade. We define the density of road intersections as the total number of road intersections per square kilometer in a District. We are able to calculate this by overlaying GIS data on roads and geographic District boundaries. The internal road connectivity increases the R-squared of our gravity model by about 5.5 percentage points. The coefficients on the road intersection density for the supplier and client Districts are statistically significant at the 1% level, as is the interaction thereof. While this does not imply any cause to effect, it is a strong signal that infrastructure connectivity matters.

Differences in the level of connectivity in the country quite large, with parts of the East and the North of the country very disconnected. The map in figure 28 and table 32 list the level of connectivity by District.

Figure 28: Map representing road density, by District

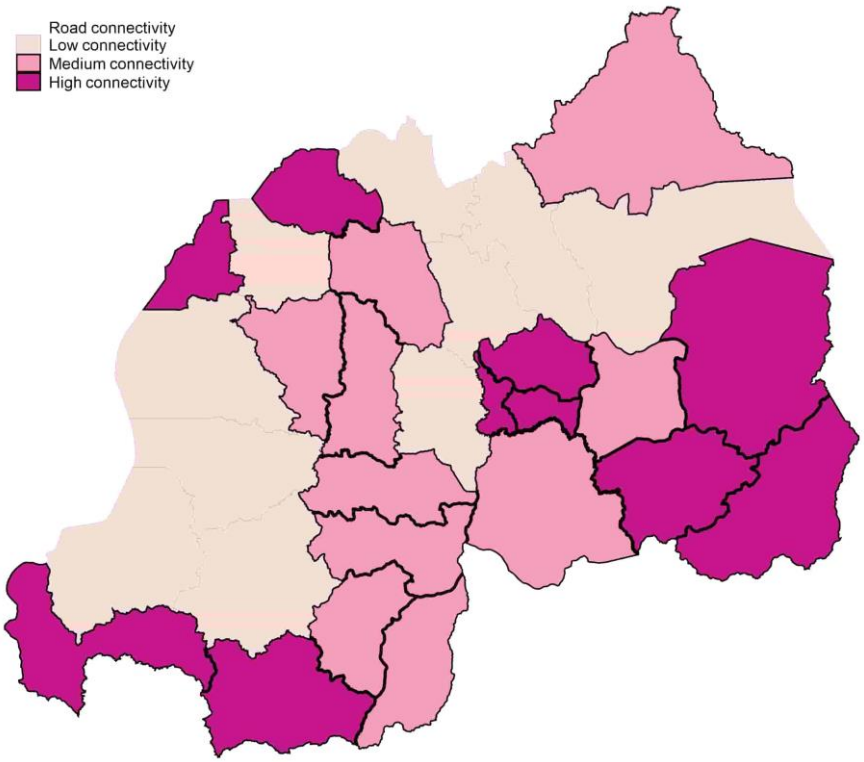


Table 32: Difference between current and predicted proportion of domestic exports, by District

Rank	District	Intersection density (intersections per sq kilometer)
1	Kigali	33.9
2	Rubavu	12.4
3	Kirehe	6.2
4	Kayonza	4.6
5	Musanze	4.1
6	Rusizi	4.0
7	Nyaruguru	3.9
8	Ngoma	3.7
9	Rwamagana	2.9
10	Nyagatare	2.8
11	Huye	2.3
12	Bugesera	1.6
13	Muhanga	1.6
14	Ngororero	1.3
15	Ruhango	1.2
16	Nyanza	1.0
17	Gisagara	0.9
18	Gakenke	0.8
19	Kamonyi	0.8
20	Nyabihu	0.8
21	Gatsibo	0.7

22	Nyamagabe	0.7
23	Nyamasheke	0.7
24	Karongi	0.5
25	Rulindo	0.5
26	Gicumbi	0.5
27	Burera	0.3
28	Rutsiro	0.3

7. Conclusions

This report provides policy makers with new information about the economic geography of Rwanda and news ways of looking at geographic trends. It puts Rwanda's specificities - including its historically low urbanization rate, high population density across the territory and high population growth rates in urban areas - into context. It achieves this by combining information on population patterns, firm location and growth rates, structural transformation and internal regional trade in the country. With the complexity analysis, the smart specialization framework and the trade gravity analysis it also provides some interesting tools for policy makers to consider.

We summarize some of the key messages from the analysis and articulate policy implications:

Population growth in secondary cities: an opportunity and a challenge that needs careful planning

This study confirms that Rwanda is urbanizing quickly, with high population growth rates in both Kigali and secondary cities. Secondary cities that were experiencing the fastest population growth rates between 2012 and 2015 included Rubavu (5.5% per year), Musanze (4.1% per year), and smaller towns such as Byumba and Nyagatare (more than 10% per year). Evidence from the EICV 5 datasets reveals that people are moving to cities in order to gain employment or to seek further education. It seems to be "pull factors" that are attracting internal migrants away from rural areas and towards cities. The immediate surroundings of secondary cities are also densely populated, suggesting that they will gradually be integrated into the city ecosystem, generating greater scale and opportunities for growth.

An important trend to be aware of is that it is people in the wealthiest population quintile (as per EICV 5) that are currently migrating from rural to urban areas; this will not always be the case. This has several important implications. First, current trends contribute to creating greater spatial imbalances. These growing spatial imbalances are evident from a number of findings in this report, including for example the low integration into the economy of rural areas (see for example the reach of EBM machines or the low connectivity of Nyamasheke District). Second, this indicates that there is a barrier to the migration of the poorest. One possibility is that the cost of relocation or the cost of living in the city is simply too high for people in the poorest quintiles. Third, the poorest migrants are currently re-locating to other rural areas, but this will not always be the case. Push factors, including the loss of land, the loss of employment and the lack of opportunities, is what is driving the migration of the poorest. As land becomes scarcer and competition for farm-jobs as labourers increases, these migrants will look for new opportunities in cities. This will be even further pressure on low cost housing and job creation. It is important for policy makers to start thinking ahead, about what greater migration of much poorer households in the future might imply for urban development policies.

The study also shows that population growth tends to precede firm creation and structural transformation. It seems to be the case that people move first, then firm creation and structural transformation follows. Further research could investigate whether this sizeable population inflow is fully absorbed by a growing workforce; if this was not the case, urban unemployment or high levels of

underemployment would become a key policy challenge. Similarly, future work could also assess whether there are bottle-necks in the provision of urban infrastructure that generate negative urbanization externalities, hampering the economic and social benefits of the urbanization process.

Prioritize resources between secondary cities - Rubavu has the highest potential

This study shows that secondary cities are not equivalent in their size or potential for future growth. There is a lot of variation in the demographic and economic footprint of secondary cities. Given limited resources, spatial development policies should take these differences into account in the allocation of funding and the selection of priorities for the spatial development of the country.

Based on this study, Rubavu - across multiple metrics - appears to be the city with the highest potential for growth. Rubavu has by far the largest population of Rwanda's secondary cities and has sustained amongst the highest population growth rates. It also has the greatest number of firms among secondary cities and has been experiencing comparatively high firm creation rates. Its economy is converging faster than any other towards Kigali city, moving away from an agriculture-based economy towards other economic activities. It is poised to grow further. On firm creation, structural transformation and internal trade flows, Rubavu is lagging behind its population. We have shown that in the Rwandan context, population growth can precede economic growth, suggesting that Rubavu has a high "catch-up" potential. Furthermore, it is located in a strategic cross-border location by Goma, it is next to Rwanda's second largest secondary city, Musanze, and has by far the highest road connectivity of any other secondary city. Its economic center, Gisenyi Sector, is a very vibrant economic center.

Manage key spatial imbalances: invest in connecting Nyamasheke District to the economy

We observe the biggest disconnect between population levels and trade predictions in Nyamasheke District. Despite having comparatively high population levels and being located on a strategic highway along the Kivu Belt, Nyamasheke is disconnected from Rwanda's EBM economy. It is a District with very low urbanization rates and no significant towns. The inner country of Nyamasheke has amongst the lowest road connectivity levels in the country. Nyamasheke does not have an asphalted road connection to the west of the country, connecting it to Nyanza or Muhanga for example. Providing Nyamasheke with the connectivity it needs can yield high trade benefits and lead to a more accelerated levels of urbanization in the District.

Think beyond the boundaries of specific cities - local connectivity and high-density population belts

Population patterns suggest it is important to think beyond the boundaries of specific cities, or administrative areas such as provinces and districts. **This is important for two reasons. First Rwanda is urbanizing not only in and around cities, but also along broad axes connecting cities.** The policy makers might also consider the introduction of new administrative units that match more closely the functional urban agglomerations, so that policy fragmentation is minimized, and decisions are taken at the right spatial level. In particular, we identify four main urbanization axes: (i) the area in and around the capital, Kigali City; (ii) the north-western corridor of the country between Rubavu, Rwanda’s second city in terms of population, and Musanze, an area we refer to as the “Virunga belt”;

(iii) the Kigali, Muhanga to Huye corridor, along Rwanda's main highway, which we refer to as the "Southern belt"; and (iv) the "Lake Kivu belt" – from Rubavu, through to Karongi and Rusizi. While the Eastern Province remains comparatively less dense, it is quickly picking up. The Eastern Province has experienced the highest population growth rates since 2002.

The second reason it is important to think beyond city boundaries, is because evidence suggests that cities have an influence over a much larger territory than the immediate city boundaries. One of the key messages of this study is that Rwanda's economy is very concentrated in the capital and in small little urban Sectors within secondary cities, near the city-center.The potential of a city is not only determined by the population levels within its boundaries, or right in the city-center, but also by the population in its surrounding areas. Importantly, growing urban centers can also have a poverty-alleviating effect on the rural population nearby. The cities with the greatest potential from that perspective are Musanze, which had more than 500,000 people living within 15km of the City in 2012; Rubavu with a population of about 373,000 in its vicinity in 2012; Huye with a population of 364,000; and Muhanga with 344,000. Deepening the local connectivity of the economies of these cities to this large population pool is strategically important (see for example Cali and Menon on the effects of urban spill-overs on poverty reduction in neighbouring rural communities, 2009) [36].

Infrastructure matters

We have shown in this study that road infrastructure matters and that it potentially has a large effect on trade. From a policy prospective, it is important to understand whether improved transport infrastructures would have a "centrifugal" effect, i.e., would result in the decentralization of economic activities away from the Capital, or rather would have a "centripetal" effect, i.e., economic activities would further concentrate in Kigali. The centrifugal forces will prevail for activities for which input costs are lower in smaller cities, as improved transportation infrastructure would make easier to serve the larger final market in Kigali. The centripetal effect would instead dominate for those high value-added activities for which urbanization externalities and agglomeration benefits are particularly important, like e.g. advanced services and the knowledge-based economy.

One issue that we were not able to directly address, but that is central to connecting Rwanda's economy, is the cost of mobility. Better infrastructure is not sufficient to generate the intended growth effects; people and firms need to be able to afford the costs of transport.

Risks associated with place-based sector specialization policies

Rwanda's city branding strategy needs to be managed with care and to be combined with other non-sector specific policies. We find that there is overlap between the brand names proposed for Rwanda's secondary cities and the areas in which these cities have a revealed comparative advantage. However, having a revealed comparative advantage in a given activity within the Rwandan context, does not necessarily imply that secondary cities will have the required capabilities to sustain growth in that sector. We have shown, using a smart specialization model, that promoting a place-based policy

[36] Calì, M., & Menon, C. (2013). Does Urbanization Affect Rural Poverty? Evidence from Indian Districts. The World Bank economic review, 27(2), 171-201

targeting greater specialization in specific economic sectors of activity can be a high-risk strategy for secondary cities. It would in some cases entail creating sectors from scratch or starting from a low base. This does not mean that a sector-focused approach would fail, but it does mean that a sector-specialization policy would involve risks, with a high probability of failure, but also high rewards if the policy succeeds. Given the high risks we recommend that sector-specialization policies not be the core pillar of any spatial development or city development strategy, but rather one of several pillars.

Another important lesson from the discussion on smart specialization is that different types of economic development strategies might be required for different types of regions. Secondary cities really have the option between two types of sector strategies: (i) either a high risk approach, with a high risk of failure, but high returns if it succeeds; or (ii) a "slow road" policy, starting with less complex activities that are more achievable and gradually upgrading the firm-level capabilities of the city. This policy would have lower returns in the short term, but a higher likelihood of success.

Branches play a very important role

The analysis also reveals that branches are playing a very important role in transforming the economic geography and the economic development of Rwanda. Branches are the fastest growing group of firms. Branches introduce products and services to locations that were not available previously. They weigh heavily on local economies, especially in locations close to national borders. In the city of Rubavu for example, branches contributed to almost 40% of total sales; in Huye, branches contributed to 35% of sales; in Nyamata about 30% of sales; in Byumba and Rusizi about 26% of sales. We also show that branches are not only important locally, but also for cross-border transactions. There is a high concentration of branches in areas of the country that are close to national borders. The branches of Rwandan banks, supermarkets and accommodation providers in cities that are close to a border do not only service Rwandan customers, but also individuals and companies located on the opposite side of the border. We recommend that policy makers look into options to facilitate the growth of Rwanda's branch economy.

Appendix A: Data Limitations

Electronic Billing Machine (EBM) data

This report relies on the extensive use of the Electronic Billing Machines dataset of the Rwandan Revenue Authority, which introduced these machines in 2013 for tax compliance purposes. Although the data is a unique dataset that has never been used in the Rwandan context for the purpose of inter-regional trade analysis, and also has incredible potential it also has a number of limitations.

First, EBM data is noisy; all data is manually input and registered which means that it is prone to errors and inconsistencies. As such, our analysis of the EBM dataset excludes any anomalous results while compiling the dataset.

Second, EBM data is only representative of formal firms; moreover, it is only representative of formal firms earning revenues greater than RWF 20 million annually. As such, analysis of EBM data is only representative of large formal entities that comply with regulations. Of the approximately 13,566 formal firms in Rwanda (Establishment Census 2017), 88% of them have at least one EBM machine. The scope of our analysis – wherever EBM data is used - is therefore restricted to these types of firms.

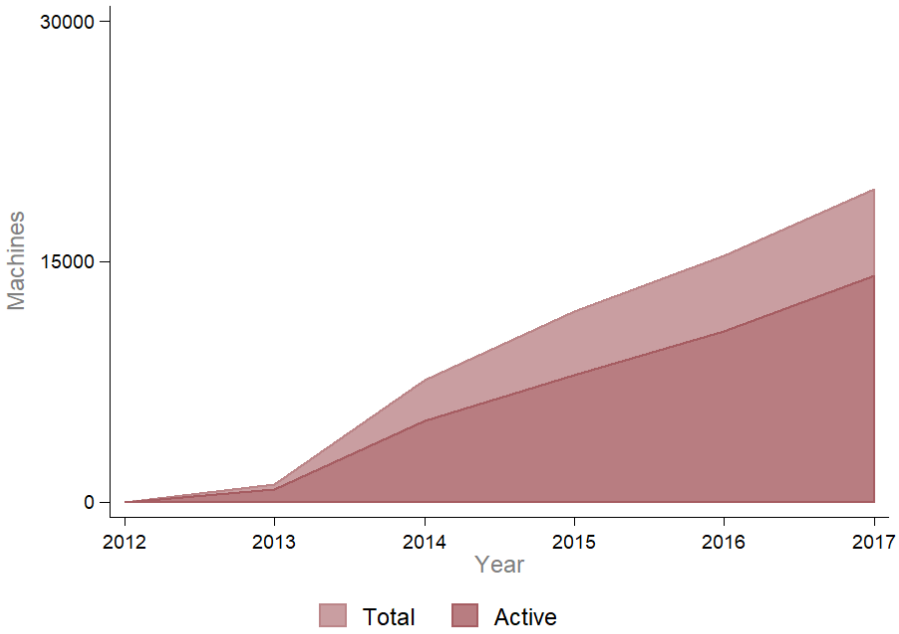
Third, even though EBM machines are required to be used by all formal firms, a large proportion of firms with EBM machines do not actively use them. While there has been recent growth in the adoption and use of EBM devices by Rwandese firms, there is still a large proportion of firms (~58%) that do not use the machines.

suggests that the data represent an increasing potential for research on the economic activity of the country**.** Not only is there a steady growth in the number of EBM machines in circulation, but the number of actively used machines – that is, those that have issued a receipt since they were purchased – has also steadily increased over time. This is highlighted in Figure 29 below.

Table 33: EBM machines and formal firms

No. of Registered EBM machines in Rwanda	**24,389**
No. of Active EBM machines in Rwanda (issued a receipt in the last year)	14,213
No. of firms with EBM machines	12,068
Products/ sold identified based on Laterite's Machine Learning algorithm	302
% of formal firms in Rwanda (Establishment Census 2017)	7.5
% of EBM machines located in Kigali province	74.3
% of formal firms located in Kigali (Establishment Census 2017)	49

Figure 29: Growth in the stock of total EBM machines and active EBM machines over time



Fourth, our location data, while being as accurate as possible, includes a number of key assumptions. As highlighted in chapter 2, we based machine locations on

Further, our data is based on SDC registry data rather than actual EBM machine location data. This means that one of our key assumptions is that the location where an EBM machine is located is similar to the location where it registered, which might not necessarily be true. While access to airtime data – data that is transmitted from the device to the RRA – would have allowed us to capture more precise geographic data, this was unavailable for this study.

Fifth, all our analysis includes sales value rather than value add, which means that our analysis of flows includes domestic "re-exports." We did not compute value added for transactions by deducting any formal inputs registered by firms from their total sales due to difficulties in obtaining exactly what products were used as inputs into a final product, and what proportion of inputs were used in producing output products. Most of our analysis of sales data was conducted at the receipt level.

Sixth, we caution that any analysis of product level data is only revealing of products that are traded and sold rather than what is produced in the country. While our machine learning tool identified and classified products in the EBM dataset, it is not always the case that any of these products are actually produced in the locations where they are sold. Many are likely to be imports. As such, the data might be more revealing of firm's inputs and households' consumption patterns than it is of the production capacities of any region in the country.

Finally, EBM data analysis of trade flows is largely limited to Business-to-business transactions amongst formal firms. Given that receipts issued from businesses to customers almost never have client TINs recorded, the only way we are able to determine the origin and destination of goods is to analyze the flow of B2B transactions.

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