STRENGTHEN Publication Series

Working Paper No. 13 – September 2019

International Labour Organization

1919·2019

Sectoral employment multipliers in Rwanda: Comparing local multipliers and input-output analysis

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This document has been produced by the International Labour Office with the financial assistance of the European Union.

Development and Investment Branch

Employment Policy Department

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Comparing local multipliers and input-output analysis

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2019

International Labour Organization – Geneva

ISSN 2519-4941 = Strengthen publication series (Print)
ISSN 2519-495X = Strengthen publication series (Online)

First published 2019

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Printed by the International labour Office, Geneva, Switzerland

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Acknowledgements

This document has been produced by the International Labour Office with the financial assistance of the European Union. We would like to thank the National Institute of Statistics of Rwanda in particular Dominique Habimana and Jean Marc Mukundabantu.

Abstract

Fast population growth in sub-Saharan Africa questions the ability of the labor market to absorb large inflows of workers. This paper measures the employment potential of agriculture, tradable and nontradable sectors in Rwanda, by estimating local multipliers, a methodology based on census data that focuses on local labor markets. We show that the tradable sector displays the largest employment potential as 1 job created in the tradable sector leads to the creation of 6 to 7 jobs in the local economy. Additionally, the multipliers associated with the nontradable sector are positive but much smaller in comparison. Lastly, the multipliers associated with agriculture are negative highlighting the gradual shift away from subsistence farming. Contrastingly, alternative employment multipliers based on input-output data underestimate the importance of the tradable sector and overestimate the role of agriculture for jobs creation.

Keywords: Local multiplier, tradable, nontradable, local labor market.

JEL classifications: J23, J46, R11, R23, O17.

0. Introduction

Rwanda displays strong economic performances over the past 15 years in particular with respect to growth of GDP per capita (7 percent on average) and with respect to structural transformation. The share of agriculture employment has declined substantially in the 2000s, while not only services but manufacturing as well have seen their relative shares increasing in total employment.[1] However, Rwanda remains a predominantly rural economy, with agriculture still accounting for 68 percent of total employment in 2014.[2] The employment creation potential of different sectors becomes crucial for structural transformation to continue especially in a country with a young and fast growing labor force. 43% of the population is younger than 16 years old according to the census 2012 and the working age population increased by half a million individuals between 2011 and 2014.

In this paper, we assess the employment creation potential of agriculture, manufacturing and service sectors focusing on local labor markets. We do so by applying the local multiplier methodology proposed by Moretti (2010), which makes use of the employment, sectoral and geographic information contained in the censuses 2002 and 2012 in Rwanda. We then compare local multipliers with alternative employment multipliers based on input-output analysis that informs us about the backward linkages between sectors from a production perspective. The industrial classification is such that manufacturing and service sectors correspond to tradable and nontradable sectors. The terms are used inter-changeably in the rest of the paper.

We find a clear hierarchy between sectors. The sector with the highest local multiplier is the tradable sector with a multiplier comprised between 6 and 7. For every job created in the tradable sector 6 to 7 jobs are created locally in the rest of the economy. On the contrary, jobs created in the nontradable sector as an aggregate have a negligible impact on the local labor market. Certain nontradable subsectors display positive and moderate multipliers as sectoral disaggregation enable to capture the impact of nontradable jobs creation on other nontradable subsectors. Additionally, the multiplier associated with agriculture is negative as workers are moving away from subsistence agriculture into tradable and nontradable jobs. These results are robust to the inclusion of control variables as well as to an instrumental variable strategy based on the shift-share approach Bartik (1991).

Comparing local multipliers with input-output multipliers for the tradable sector, the former far exceed the later. We discuss two possible transmission channels that could account for these differences: i) the demand for locally produced goods as wages in the tradable sector are likely to be higher than the average wage in the economy ii) the quality of the jobs created: many informal jobs rather than fewer formal jobs. We show that the multiplier increases with the employment status and with the skills of the jobs created. We interpret this result as an indirect evidence of the importance of the first transmission channel. We also underline that employment multipliers based on input-output tables may lead to the wrong policy recommendation as the highest multipliers are related to agriculture as a result of the low productivity of this sector.

This paper is related to the literature on local multiplier that has been applied to high income countries mostly. Moretti (2010) estimates the local multiplier of tradable

[1] As shown in Table 1, employment in agriculture has declined by 13 percentage points, while manufacturing employment has doubled from very low level and employment in services increased from 11 percent to 22 percent of total employment based on census data 2002 and 2012.

[2] See Figure 2. This percentage is based on the household surveys 2014 (EICV IV). In the census 2012, agriculture employment is 74 percent of total employment.

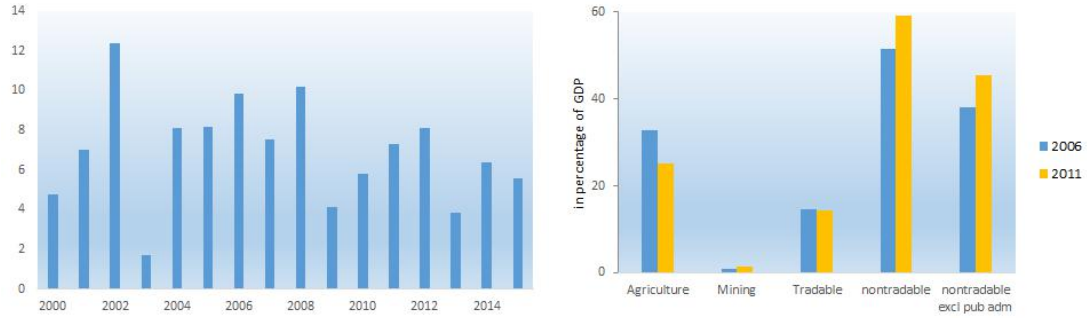
jobs on nontradable jobs to be around 1.59 in the United States. van Dijk (2017) revises this estimate to 1.02 as a result of alternative sector composition and definition of the instrumental variables. Moretti and Thulin (2013) find a multiplier of 0.58 for Sweden. This paper is also related to the vast literature on structural transformation in particular with the debate on unconditional convergence Rodrik (2013) or de Vries et al. (2015).

The paper is organised as follow. Section 2 gives a quick overview of the economy of Rwanda and of the labor market challenges. Section 3 presents the local multiplier approach and their estimates at the level of agriculture, manufacturing and services as well as at a more disaggregated sectoral level. Section 4 presents the employment multipliers based on the input-output analysis and discusses the two approaches. Section 5 looks at possible transmission channels by estimating local multipliers across employment status and skills.

1. Structural transformation and labour market challenges

Rwanda is a small landlocked country with high transport costs. However, the economic performances of Rwanda over the past 15 years are noticeable. The growth rate of GDP per capita is 6.9 percent on average over the period 2000-2015. This overall good economic performances in terms of economic activity have taken place along a decline in agriculture and the emergence of services. Between 2006 and 2011, the share of agriculture in total production has declined from 33 percent to 25 percent. Over the same period, services (excluding public administrations) have increased their share in total production from 38 to 45 percent. Including public administrations, the increase goes from 51 to 59 percent. The shift away from agriculture has not been associated with a development of the tradable sector (manufacturing industries). The production of the tradable sector remains constant between 14 and 15 percent over this period.[3]

Figure 1. Growth and sectoral composition of GDP



(a) GDP per capita growth

(b) Sectoral composition of GDP

These figures report the average GDP per capita growth (in percent) in PPP and the sectoral composition of GDP. Data sources are national accounts and input-output tables 2006 and 2011.

The tradable vs nontradable sectors classification reflects the ability of economic activities to move geographically across the domestic economy. What characterise nontradable sectors is that nontradable goods are produced and consumed locally. Ag-

[3]Tradable sector includes manufacturing industries but excludes "electricity, gas and water" as well as "construction". These two sectors are aggregated with services in the nontradable sector.

Table 1. Long-term perspective on the labor market

Year	Pop	Et/Pop(> 16)	A/Et	M/Et	T/Et	NT/Et
2002	$8.5M$	77%	87%	0.2%	1.3%	11.4%
2012	$10M$	63%	74%	0.5%	3%	22%

This table presents descriptive statistics of the labor market based on census data 2002 and 2012. Population (Pop), Employment (Et), Employment in agriculture (A), mining (M), tradable (T), nontradable (NT)

riculture is excluded as agriculture production can be sold across the entire economy but its production is determined by the availability of lands and climate.

With respect to the labour market, Rwanda has registered very positive trends since the mid-2000s. However, the labour market faces some challenges: the labour force is growing quickly and employment is still dominated by agriculture and informality.

Figure 2. Agriculture employment and informality prevail in Rwanda

(a) Tradable and nontradable

(b) Employment status

These figures report employment accross sectors and employment across status. Data sources are households' surveys EICV III and EICV IV.

The labor market faces large inflows of workers. Out of a population of 10 millions in the 2012 census, the share of individuals younger than 16 years old is 43 percent. One consequence is that the labor market must generate enough jobs to absorb new inflows. Working age population (16 years and above) has increased by roughly half a million between 2011 and 2014 up to 6.4 million. Total employment has increased in line with the working age population. Total employment reaches 5.4 million in 2014 up from 4.9 million in 2011.

The prevalence of agriculture in the Rwandese economy is striking when looking at sectoral employment. Employment in agriculture represents 68 percent of total employment in 2014. This share is down from 72 percent in 2011 (see figure 2a). The decline in agriculture employment has taken place along an increase of employment in services (also labelled as tradable) from 23 percent to 29 percent. In line with sectoral production, employment in tradable (manufacture) has remained constant at a low level (2 percent). Using census data, tradable employment doubles from 1.3 percent to 3 percent of total employment between 2002 and 2012 (see Table 1). The prevalence of agriculture is more pronounced with respect to employment rather than production.

Two additional labor market challenges can be underlined. **Employment remains mostly informal.** In Table 2b, wage employment account for roughly one third of total employment. The proportion between wage and non-wage employment has remained constant between 2011 and 2014. However, self-employment declined by 13 percentage points between 2002 and 2012 based on census data. Additionally, **the labor force is mainly unskilled**. Individuals participating in the labor market with "no education" or "incomplete primary" education amount to 63 percent of the labor force. Despite the improvement of the level of education of the population between 2011 and 2014, a large majority of workers are still unskilled.

2. Local multipliers: a clear hierarchy between sectors

In this section, we compute employment multipliers at the sectoral level based on the local multipliers methodology. We first present the methodology and review existing results, which concern high income countries mostly. We then discuss the application of local multipliers to low and medium income countries and how developing countries context may impact the size of multipliers. We then present our empirical results for Rwanda in two steps. In a first step we reproduce the multiplier as initially presented by Moretti (2010): i.e. multipliers between two broad categories, the tradable and the nontradable sectors. We also add the multiplier associated with agriculture given its importance in Rwanda. In a second step, we estimate the multiplier for a selection of subsectors.

2.1 Methodology

Local multipliers is a methodology proposed recently by Moretti (2010) as a complement to input-output analysis. This methodology aims at measuring the employment potential of different economic sectors. In particular, local multipliers intend to measure the impact of an increase in tradable employment on nontradable employment as well as the impact of an increase in tradable employment in a particular tradable subsector on other tradable sectors.

The mechanisms behind local multipliers are as follow. The increase in tradable employment in a given geographic entity such as a municipality for instance should necessarily stimulates employment in nontradable sectors in the same municipality as nontradable goods are produced and consumed locally. The size of the effect depends on the extent to which salaries are consumed locally. In addition, the multiplier may be influenced by the tradable versus nontradable composition of the economy, the local supply chain and the level of skills/wages of the tradable jobs created initially.

In addition, the increase in tradable jobs may have ambivalent effects on other tradable jobs. On the one hand, agglomeration economies may have a positive impact on other tradable jobs (see Glaeser et al. 1992 or Henderson et al. 1995). Agglomeration effects capture the positive externalities that arise from the proximity of firms. Examples of these advantages are sharing a common labour pool and intermediate inputs or minimizing trade and transaction costs. On the other hand, an increase in tradable employment may lead to an increase in wages and a reduction in the competitiveness of tradable firms.

Local multipliers also predict that an increase in nontradable employment has a limited impact on tradable employment. This flows from the characteristic of tradable

goods that can be produced and consumed in different geographic entity.

Additionally, increases in employment in tradable and nontradable sectors are unlikely to stimulate agricultural employment as a result of the Engel law.[4] One could even expect a negative coefficient as jobs in nontradable sectors maybe a substitute to jobs in agriculture. Lastly, jobs in agriculture are unlikely to stimulate either tradable jobs or nontradable jobs creation given their subsistence nature in general.

Local multipliers make use of the socio-economic information (geographic, employment and industrial classification) contained in the census data to construct changes in employment between two census, employment being measured at the sectoral level (tradable, nontradable, agriculture) and at the level of agglomeration and/or administrative entity. In Rwanda, two censuses are available in 2002 and 2012. The census represents 10 percent of the population around 1 million observations in the latest census. Administratively, Rwanda is structured into 5 provinces, 30 districts and 416 sectors. There is no intermediate administrative entity between districts and sectors. We choose the latter as the number of districts is too limited. The methodology consists in estimating two equations:

$$\Delta N_{c,t}^{NT} = \alpha + \beta \Delta N_{c,t}^{T} + \eta X_{m,t-1} + \epsilon_{c,t} \tag{1}$$

Equation 1 captures the correlation between changes in employment in the tradable sector $\Delta N_{c,t}^{T}$ and nontradable sector $\Delta N_{c,t}^{NT}$ measured in the administrative entity c. α and $\alpha^{'}$ are constants and $\epsilon_{c,t}$ is an error term clustered at the level of the administrative entity. $X_{m,t-1}$ is the population of the administrative entity in the last period. Controlling for the size is important as sectoral job creation could be related to population. The estimation of Equation 1 will be conducted for the different possible combinations between our three main sectors : tradable, nontradable and agriculture. Equation 1 will also be estimated with and without a constant term. A constant term implicitly assumes that all administrative entities generate the same ammount of new jobs α irrespective of their size/population. Equation 1 will aslo be estimated controling for the size of the administrative entity measured as the log of total population in the last period.

$$\Delta N_{c,t}^{T1} = \alpha^{'} + \beta^{'} \Delta N_{c,t}^{T2} + \eta X_{m,t-1} + \epsilon_{c,t} \tag{2}$$

Equation 2 captures the ambivalent effects between agglomeration economies and competitiveness effect. It captures the correlation of changes in employment $\Delta N_{c,t}^{T1}$ in the tradable subsector $T1$ in the administrative entity c with the change in employment in the rest of the tradable sector $\Delta N_{c,t}^{T2}$ in the same the administrative entity.

These equations are estimated in two ways. The first estimation is a standard OLS estimation. The main shortcomings of the OLS estimation are the risk of i) reverse causality ii) omitted variable. It follows that the second estimation is an instrumental variable estimation based on the shift-share approach as proposed by Bartik (1991). The shift-share approach (eq 3) assumes that the change in national employment for sector j is independent from the local labour market in the administrative entity c. The level of employment in sector j in the administrative entity c at $t-s$ is used as a weight for the change in national employment (measured net of employment in the administrative entity c).

[4] As income rise the proportion of income spent on food items declines.

Table 2. Existing local multipliers in high income countries

	USA Moretti (2010)	USA Dijk (2016)	Sweden MT (2013)
Tradable on nontradable	1.59***	1.02***	0.48*
Tradable on other tradable	0.26	0.85***	0.33***
Tradable durable on nontradable	0.73	0.5	
Tradable nondurable on nontradable	1.89***	1.26***	
Tradable skilled on nontradable	2.52*	1.87	2.97***
Tradable unskilled on nontradable	1.04	0.5	−0.15
Tradable high tech on nontradable			1.1***

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. This table presents the existing estimates of local multipliers.

$$\Delta \tilde{N}^{T}_{m,t} = \sum_{j \epsilon T} N_{j,c,t-s} \left(\log \left(N_{j,t} - N_{j,c,t} \right) - \log \left(N_{j,t-1} - N_{j,c,t-s} \right) \right) \tag{3}$$

Local multipliers have been only applied to a handful of high income countries as summarized in Table 2. The initial contribution of Moretti (2010) focusing on the United States can be summarized as follow: i) every job created in the tradable sector generates 1.6 jobs in the nontradable sector ii) local multipliers increase with the skills/technology level of the tradable jobs created iii) there is no evidence of either agglomeration effects or competitiveness effects. Moretti and Thulin (2013) applied the methodology to Sweden with similar conclusions. The multiplier of tradable jobs on nontradable jobs is 0.48 significantly smaller than in the USA and there are evidence of small agglomeration economies with a coefficient $\beta^{'}$ of 0.33. Recently, van Dijk (2017) revised the initial contribution by Moretti, pointing that the multiplier of tradable on nontradable jobs is closer to unity (1.02) and that the impact of tradable jobs on other tradable jobs is positive and significantly different from zero at 0.85 (see Table 2). Beyond the tradable/nontradable interlinkages, this methodology has been used more widely to measure inter-sectoral employment correlation. For instance Faggio and Overman (2014) have applied the same methodology to measure the impact of public job creation on private employment highlighting the opposite effects on tradable jobs and nontradable jobs.

2.2 Local multipliers in low and medium income countries

In the context of low and medium income countries, local multipliers have various advantages. First census data are the first data collected in low income countries and census exists for many decades. The census do not always includes the socio-economic information necessary to estimate local multipliers but at least there are censuses available for most of countries. In comparison, alternative data source such as input-output tables have been produced much later with the development of national account and are not available on an annual frequency. Secondly, the construction of employment satellite account to match the input-output tables is made more difficult by the lack of households' surveys. On the contrary, the main shortcoming of census data is that they do not capture the multiplicity of jobs in low and medium income

countries. However, they contain information on employment status and enable to make a distinction between formal and informal employment.

The specificity of low and medium income countries may have a great impact on the size of the multiplier. First given wage dispersion and low earnings in low income countries, the creation of relatively skilled jobs in the tradable sector is likely to have a strong impact on employment in the nontradable sector through the consumption of locally produced goods. Second, the prevalence of informality may contribute to increase the size of the multipliers as many informal jobs may be created rather than fewer formal jobs.

2.3 Local multipliers - tradable, nontradable and agriculture sectors

Table 3 displays the results of the estimation of local multipliers in Rwanda. A clear hierarchy appears between sectors. Tradable jobs have a positive, large and significant multiplier. Nontradable jobs have a positive and significant multiplier but the coefficient is small. The multiplier associated with agriculture whether as a dependent or independent variable is negative in most case but not robust to the inclusion of control variables.

Table 3 summarizes the estimation without a constant and without controlling for size. The inclusion of a constant term implicitely assumes that each administrative entity produces on average the same number of jobs in the tradable sector irrespective of its characteristics such as rural/urban, size or geographic location (close or far to the airport and to the road network). Including these two elements in the estimation and its impact on the coefficient is discussed below and the tables can be found in the appendix. The local multiplier of tradable jobs on nontradable jobs is comprised between 6 and 7 depending on the type of estimation OLS or IV. The coefficient is significant at 1 percent. The coefficient is also robust to the exclusion of geographic entity with zero jobs in the tradable sector.

The size of the multiplier exceeds the estimate for high income countries by a factor of 6. One explanation is that the demand for locally produced goods is a much stronger transmission channel in low and medium income countries. Wage inequalities are high in low income countries. This entails that workers in tradable sectors receive higher wages compared to workers in nontradable sectors. In addition, the price of locally produced goods is low due to the extent of informality and under-employment. An alternative explanation is that the jobs created are mostly informal jobs rather than fewer formal jobs. We further explore possible transmission channels in section 4. Note that in Table 3, the large number of administrative entity (416) and the small size of the tradable sector implies that some of the administrative entity have zero tradable jobs. These administrative entity with zero jobs are excluded from the estimation.

The coefficient of nontradable jobs on tradable jobs is comprised between 0.08 and 0.1. This coefficient is small and is in line with the conceptual framework proposed. The increase in nontradable job in a given administrative entity does not lead to important tradable job creation as the locations where tradable goods are produced and consumed are independent from each other.

The dynamic of job creation between agriculture and the other two sectors is always negative whether agriculture employment is a dependent variable or an independent variable. This negative coefficient is in line with the progressive decline in agriculture and the rise of services, mostly, and manufacturing, to a smaller extent, at

Table 3. Local multipliers for aggregated sectors - no constant term

	ols	iv	ols	iv	ols	iv	ols	iv
	$\Delta N^{NT}_{m,t}$				$\Delta N^{A}_{m,t}$			
$\Delta N^{T}_{m,t}$	6.62***	7.73***			-1.27***	-2.12***		
	(0.48)	(1.19)			(0.37)	(0.65)		
N	407	394			404	391		
			$\Delta N^{T}_{m,t}$		$\Delta N^{A}_{m,t}$			
$\Delta N^{NT}_{m,t}$			0.10***	0.08***	-0.16***	-0.10***		
			(0.008)	(0.015)	(0.047)	(0.038)		
N			407	394	413	416		
	$\Delta N^{NT}_{m,t}$		$\Delta N^{T}_{m,t}$					
$\Delta N^{A}_{m,t}$	-0.12***	-2.02***	-0.016***	-0.33***				
	(0.05)	(0.13)	(0.005)	(0.019)				
N	413	416	404	391				
							$\Delta N^{T1}_{m,t}$	
$\Delta N^{T2}_{m,t}$							0.68***	1.30***
							(0.09)	(0.15)
N							380	350

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. This table presents the results of the estimation of equation 1 and equation 2 excluding the constant term. Equation 1 is estimated for the different combinations between tradable $\Delta N^{T}_{m,t}$, nontradable $\Delta N^{NT}_{m,t}$ and agriculture $\Delta N^{A}_{m,t}$. The table includes both the ols estimation and the instrumental variable estimation. Standard errors are in parenthesis. N is the number of geographic units in the regression.

the aggregate level. This captures the fact that workers are trying to move away from agriculture jobs into services and manufacturing jobs.

The effect between agriculture and nontradable is rather limited. We see two reasons for this. First, since agriculture remains low paid/low productive subsistence jobs, agriculture does not stimulate job creation in the nontradable sector. Indeed, the coefficient of agriculture jobs on nontradable jobs is negative at -0.33. In rural areas, individuals previously employed in agriculture are moving to services such as transport through bikes and cars or such as retailing or phone shops. These service activities may well be very low paid and comparable to subsistence activities prevailing in agriculture. In addition, the coefficient is rather small. This could be explained by the fact that when an individual shifts away from agriculture, he migrates into cities rather than remaining within the same geographic entity.

Furthermore, the coefficient of nontradable jobs on agriculture jobs is also negative and quite small at -0.1. One reason is that services are mainly rising in cities where there are already very few agriculture jobs remaining. In Rwanda, urbanisation takes place on hills while agriculture remains marginally at the bottom.

The coefficient between agriculture and tradable jobs is also negative but much larger. One explanation is that lands are either used for farming or used for production plants. This is reinforced by the fact that production plants are being constructed on the outskirt of cities and are the main reason for the reduction of arable land along with urbanisation. Additionally, one characteristic of tradable jobs is that they can absorb a large share of unskilled workers.

2.4 Robustness check

A first robustness check is to estimate equations 1 and 2 including a constant term (see Table 7 in appendix). This does not impact the hierarchy between sectors. The multiplier of tradable jobs on nontradable jobs is still large and significant. The coefficient is slightly smaller and comprised between 5 and 6. The multiplier of nontradable on tradable is not impacted and remains positive but small. The main modification is that the coefficients associated with agriculture whether as a dependent or independent variables are not significant anymore. Lastly, the impact of tradable on other tradable is slightly smaller and comprised between 0.5 and 0.8.

A second robustness check is to estimate equations 1 and 2 including a constant term but including a control variable for the size of the geographic entity (see Table 8 in appendix). Here as well the hierarchy between sectors remains after controlling for size. The coefficient for tradable on nontradable is comprised between 5.5 and 6.5. The multiplier associated with nontradable jobs on tradable jobs remains positive, significant but small. Lastly, the sign associated with agriculture is not significant at 5 percent.

Lastly, given the importance of coffee and tea in the economy of Rwanda, we include the employment level in agriculture in the last period as a control variable in the regression involving the tradable sector and the nontradable sector (see Table 9 in appendix). Coffee and tea being the main exports of Rwanda, large agriculture employment could impact the quantity of jobs created in services or in manufacturing such as food and beverage manufacturing.

The last column in Table 3 displays the impact of increasing tradable jobs in a subdivision of the tradable sector on the rest of the tradable sector. We split the

tradable sector into durable (explanatory variable) and nondurables. The coefficient is positive, significant and comprised between 0.7 and 1.3. A positive coefficient is indicative of agglomeration economies, whereby the increase in the number of tradable jobs generates economies of scale and fosters a further development of the tradable sector. A positive coefficient is also indicative that tradable jobs creation does not trigger wage inflation that would be detrimental to the growth of the tradable sector. In Table 12 in the appendix, we propose five alternative and random splits of the tradable sector. Two out five coefficients are not significant. The other three are positive and fluctuate between 0.4 and 2.7.

2.5 Local multipliers for disaggregated sectors

Local multipliers can be estimated at the level of subsectors (see Table 4 for a selection). The estimation at the subsector level confirms the hierarchy discussed in the previous section between tradable, nontradable and agriculture sectors. Multipliers associated with tradable jobs are above 10 and by far exceed any other multipliers. Some nontradable subsectors have a non negligeable multiplier comprised, which however do not exceed 10. This is in contrast with the aggregate multiplier associated with nontradable jobs presented previously that was close to zero. The main reason is that the multiplier associated with nontradable jobs at the aggregate level could not capture the impact of job creation in a nontradable subsector on other nontradable jobs. Lastly, multipliers associated with agriculture remains negative.

For instance, creating one job in the "*Wood and paper*" industry leads to the creation of more than 24 jobs in the economy decomposed into 31 jobs in the nontradable sector, 4 jobs in other tradable sector and -11 jobs in agriculture under the IV approach. Similarly, creating one job in the "*Metallic and mineral*" industry leads to the creation of 12 jobs in the economy (20 jobs in the nontradable sector, 2 jobs in other tradable sector and -10 jobs in agriculture).

While the multiplier of nontradable jobs on tradable jobs is close to zero as discussed in Table 6, some nontradable subsectors have a significant employment potential. For instance, the multiplier associated with the "*construction*" sector is 3.12. "*Transport*" has a multiplier of 4.01 and "*Hotels and restaurants*" has a multiplier of 9.7. These multipliers remained significantly smaller than that for the tradable subsectors. Lastly, we compute the size of the multiplier associated with "*crops and horticulture*" activities given the importance of the coffee and tea production in Rwanda. The multiplier remains negative at 4.8.

3. Input-output multipliers

This section estimates production and employment multipliers based on the 2011 input-output (IO) table for Rwanda. The objective is to compare input-output multipliers with local multipliers. We first discuss local multipliers versus IO analysis. We then present output and employment multipliers. A section giving a brief overview of the IO tables and their associated multipliers as well as a section describing the construction of the employment satellite accounts can be found in the appendix.

Table 4. Local multipliers for disaggregated sectors - no constant term

	ols	iv	ols	iv	ols	iv
	$\Delta N^{NT}_{m,t}$		$\Delta N^{T}_{m,t}$		$\Delta N^{A}_{m,t}$	
Metalic, mineral	13.03***	20.98***	1.39***	2.32***	-2.20*	-10.43***
	(2.16)	(3.61)	(0.24)	(0.37)	(1.25)	(2.88)
N	357	190	351	185	356	190
Wood, paper	11.83***	31.75***	1.37***	4.29***	-2.28***	-11.43***
	(4.10)	(6.23)	(0.38)	(0.66)	(1.25)	(4.13)
N	362	328	355	324	362	327
Food, beverage	18.96***	10.39***	1.85***	1.08***	-8.82***	-2.63***
	(3.13)	(3.12)	(0.27)	(0.29)	(1.90)	(2.47)
N	291	129	288	127	290	127
Construction	2.83***	3.41***	0.51***	0.38***	-0.84***	-0.60***
	(0.22)	(0.52)	(0.03)	(0.10)	(0.27)	(0.17)
N	413	367	404	362	413	367
Transport	6.55***	4.15***	0.79***	0.58***	-1.22***	-0.64***
	(0.26)	(1.22)	(0.06)	(0.13)	(0.36)	(0.34)
N	393	305	387	300	392	303
Hotel, restaurant	12.55***	9.92***	1.44***	0.97***	-2.21***	-1.15***
	(0.91)	(2.65)	(0.18)	(0.30)	(0.84)	(0.56)
N	374	127	374	127	380	125
Crops	-0.10**	-3.5***	-0.11**	-0.65***	-0.06***	0.71***
	(0.04)	(0.22)	(0.005)	(0.03)	(0.014)	(0.12)
N	413	414	406	407	404	405

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. This table presents the results of the local multiplier for disaggregated sectors. The estimation is performed without a constant term. $\Delta N^{T}_{m,t}$ is the change in employment in the tradable sector, $\Delta N^{NT}_{m,t}$ stands for nontradable and $\Delta N^{A}_{m,t}$ for agriculture. The table includes both the ols estimation and the instrumental variable estimation. Standard errors are in parenthesis. N is the number of geographic units in the regression.

3.1 Local multipliers and input-output analysis

The local multiplier approach shares similarities with the input-output analysis to the extent that it starts from the same economic question: understanding the employment potential of sectoral policies. The two methodologies differ on a number of points. First, local multipliers rely on changes in employment across two censuses. The multiplier has a dynamic dimension and the census being usually conducted every ten years, the multipliers are medium-term multipliers. On the contrary, the input-output analysis is static especially if it is not combined with a CGE model. Second, the geographical dimension is the main innovation of local multipliers as it enables to construct a cross section/panel data of sectoral employment across administrative entities. The large number of observations allows to perform statistical tests in constrast to IO analysis. Third, local multipliers directly look at employment where IO tables require the construction of employment satellite accounts to go from production multipliers to employment multipliers. The construction of employment satellite accounts are subject to various difficulties and greatly influence the final multipliers. This is especially true when working with medium and low income countries where employment data are scarce.[5] Fourth, local multipliers estimate a reduced form equation and measure a final effect. The input-output analysis needs to be combined with a full CGE model in order to account for all of the interdependence between sectoral employment such as wage and price inflation, labour demand elasticity or consumption effects.

3.2 Production and employment multipliers

Input-output tables are available for the years 2006 and 2011 (see Xinshen 2012 as well as Pradesha and Diao 2014). A first IO table has been produced by Emini (2007). A second version with a higher level of disaggregation of the households' account has been proposed by Xinshen (2012). In the 2011's table, there are 54 sectors including 26 agriculture sectors, 13 tradable sectors and 14 nontradable sectors.[6] The 2011 coefficients are taken from the 2006 table, which implies that multipliers are the same for both years.

Production multipliers are computed by solving equation 4 (see the appendix for details):

$$X = (1 - a)^{-1} Y \tag{4}$$

with X a vector of sectoral production, Y a vector of final demand and a a matrix of technical coefficients. In Table 5, production multipliers m_p in column 2 describes the increase in output (in percentage) following a positive shock on a given sector, whose magnitude corresponds to 1% of GDP: $m_p = \frac{\sum_{i=1}^{n} \Delta X_i}{\sum_{i=1}^{n} X_i} * 100$ with n the number of sectors.

We quickly describe the different steps to go from production multipliers to employment multipliers. In a first step, we use the households' survey corresponding to the same year as the input-output table and we match the sectoral classification of these two data sources. In a second step, we identify and aggregate employment related information to produce a measure of employment at the sectoral level. In order

[5] We discuss this limitation further below.

[6] The last sector is mining.

Table 5. Input-Ouput based multipliers 2011

2011	m_p	m_e	m_a	m_t	m_{nt}
1	2	3	4	5	6
Agriculture	1.4	3.2		0.003	0.006
Tradable	2.4	1.5	6.63		1.04
Non tradable	1.8	0.8	0.35	0.04	
Coffee	1.2	2.95	0.002	0.005	0.005
Green tea	1.3	3.02	0.031	0.006	0.025
Pyrethium	1.2	2.94	0.023	0.004	0.004
Mining	1.5	1.0	0.03	0.08	0.11
Processed coffee	1.7	0.99	13.4	0.30	0.84
Processed tea	1.8	1.02	13.2	0.32	1.05
Textile and clothing	2.1	0.75	0.57	0.44	0.37
Wood, paper and printing	1.9	1.87	1.38	0.25	1.21
Non-metalic minerals	1.8	0.31	0.79	0.47	1.01
Furniture and other manufactured products	2.0	0.44	0.30	0.06	0.29
Construction	1.8	0.74	0.17	0.23	0.17
Hotels and restaurants	2.0	1.10	1.75	0.14	0.15
Transports	1.8	0.64	0.94	0.20	0.16

This table summarizes the multipliers corresponding to the IO table 2011. Column 2 is the percentage change in total production following a 1% GDP shock on the corresponding sector. Column 3 is the corresponding percentage increase in total hours worked in the economy. Columns 4 to 6 display the percentage increase in total hours worked normalized by the percentage increase in hours worked in the sector subject to the shock for 3 categories: agriculture, tradable and nontradable.

to simplify the issue of multiple jobs, we choose total hours worked to measure employment.[7] In a third step, combining sectoral employment and sectoral production, we are able to measure apparent labour productivity. In a fourth step, the production multipliers are combined with labour productivity to produce employment multipliers. The construction of the employment satellite account can be found in the appendix.

Apparent employment productivity is measured as $\alpha_i = \frac{X_i}{Et_i}$ with Et_i and X_i total hours worked and total production in sector i (see Table 15 in appendix). The employment multiplier is computed as follow: $m_e = \frac{\sum_{i=1}^{n} \Delta X_i/\alpha_i}{\sum_{i=1}^{n} Et_i} * 100$. Regarding the subsectors that are disaggregated in the IO table but not in the household survey, we use labour productivity of the aggregate sector. For coffee for instance, we use labor productivity of the agriculture sector as a whole. The employment multipliers m_e are presented in Table 5 column 3.

Column 4 to 6 summarizes the increase in hours worked aggregated across three categories normalized by the increase in hours worked in the sector subject to the shock. The three categories are agriculture, tradable and nontradable. For instance the multiplier in the tradable sector following a shock on sector j is $m_t = \frac{\sum_{i=1}^{n_t} \Delta X_i/\alpha_i}{\Delta X_j/\alpha_j}$. Employment creation in the sector subject to the shock is $\Delta X_j/\alpha_j$. The aggregation of job creation in the n_t tradable subsector is $\sum_{i=1}^{n_t} \Delta X_i/\alpha_i$. In the case where j belongs to i, $\Delta X_j/\alpha_j$ is subtracted from the numerator. Column 4 to 6 can be directly compared with local multipliers.

[7] Looking at the extensive margin or at the intensive margin of emplyoment does not impact the results.

Looking at production multipliers, one striking characteristic is the small variance in the production multipliers across sectors. While the ranking between sectors is similar to the ranking of local multipliers, the differences are small when looking at production multipliers. The production multiplier is 2.4 for the tradable sectors, 1.8 for the nontradable sector and 1.4 for agriculture. At a higher level of disaggregation, there are very little difference between the multipliers for tradable goods (manufactured goods) and nontradable goods (services and construction). The multipliers for tradable goods are comprised between 1.7 and 2.2, while the multipliers for nontradable goods are comprised between 1.8 and 2.

When comparing the Leontief multipliers with the local multipliers, it is clear that local multipliers show much more variance depending on the type of sectors considered (tradable versus nontradable). One reason for the differences between the two multipliers could be that the Leontief multipliers are related to the production while the local multipliers are employment multipliers. For this reason, we are now computing employment multipliers.

The difference between production multipliers m_p and employment multipliers m_e is related to labour productivity within the sector of interest or along the domestic value chain. It follows that it is in the sectors where productivity is the lowest that employment multipliers are the largest. One consequence is that the hierarchy between sectors is inverted as agriculture displays the highest employment multipliers. The multiplier is around 3 against 1.5 in tradable and 0.8 in nontradable. However, columns 4 to 7 indicate that although employment creations might be large nationally, these employment creation are only located in the agriculture sector. There are no positive impact on tradable or nontradable sectors.

We are now focusing on columns 4 to 7 as the IO multipliers are more easily comparable with local multipliers. A first similarity between LM and IOM is the prediction that agriculture has little impact on tradable or nontradable employment. In light of the IO tables, agriculture has limited backward linkages with tradable and nontradable sectors. The coefficient associated with agriculture is either negative or insignificant in the LM. This reflects the structural transformation at work in Rwanda where individuals previously employed in agriculture are moving to occupations in services mostly. In addition, agriculture jobs being low productivity jobs the demand for locally produced good is limited. In fact, IO analysis does not allow for negative feedback channels, while one of the central driving force of structural transformation is that increases in demand for agriculture goods is met by higher productivity rather than higher employment or hours worked.

The main similarity between IO and local multipliers is the prediction that the nontradable sector has little impact on either the tradable sector or the agriculture sector. The employment multiplier of tradable on nontradable is positive but small (at 0.04) in the IO analysis. This is indicative that manufacturing goods are limited inputs in the production of services. In the LM analysis, the coefficient of nontradable jobs on tradable jobs is close to zero as well (at 0.08). This is indicative that services play little influence on the creation and expansion of manufacturing jobs.

The major difference is the impact of tradable jobs on nontradable jobs that is underestimated in the IO analysis. The IOM is 1.04, five to six times smaller than the LM. The IOM reflects the extent to which services enter in the production of manufacturing goods. However, the IOM fails to take into account the demand for locally produced goods. This transmission channel could be substantial as the LM increases with the skills of the jobs created. This effect is tested in the next section.

In addition, the impact of tradable jobs on agriculture jobs is small in the LM analysis given that the proportion of agricultural goods declines in consumption as income increases (Engel's law). On the contrary, the IOM of tradable on nontradable is high at 6.6 as food processing has important backward linkages with agriculture a low productive sector.

This leads us to highlight the main shortcoming of the IO analysis, which is to put too much emphasises on agriculture, whose low productivity generates high employment multipliers. Taken at face value, this would lead to the wrong policy conclusions: i.e. that we should increase agriculture employment when structural transformation intends to achieve the opposite. Another shortcoming of the IO analysis is that it only predicts positive relationship between sectors, when economic mechanisms can lead to the crowding out of certain sectors. It fails as well to captures regional discrepancies even though regional IO tables can overcome this difficulty to some extent.

These remarks also hold at a more disaggregated level when looking at i) the positive multipliers on agriculture, ii) the high multipliers related to processed coffee and tea iii) the relatively limited multipliers of tradable subsectors on nontradable subsectors or iv) the limited impact of nontradable subsectors on other nontradable subsectors.

The comparison with IO analysis is intended to highlight the contribution of local multipliers to sectoral employment potential. It goes without saying that local multipliers display their own shortcoming. One of them is the limit to which industries can be disaggregated. As the essence of LM analysis is to disaggregate sectoral employment at the local level, the industrial classification is mechanically limited especially in countries predominantly specialized in agriculture.

4. Transmission channels: the demand for locally produced goods

In the previous section we highlighted that one of the main difference between IOMs and local multipliers is the size of the multiplier of tradable jobs on nontradable jobs. In this section, we explore possible transmission channels that could account for the large value of the local multiplier. We first estimate the multiplier for different employment status and different skills as this could be indirect evidence of the demand for locally produced goods. We then look at the type of jobs created in the nontradable sector as a high multiplier could simply reflect that many informal jobs are being created.

A first result is that the multiplier increases with the employment status of the tradable jobs created. In Table 6, the multiplier associated with tradable employees jobs rise to 21, while the multiplier associated with tradable self-employed jobs remains low at 8. The multipliers for tradable jobs and for tradable self-employed jobs is similar. This indicates that most of the jobs remain informal jobs in Rwanda.

Estimating the multipliers with respect to skills confirms this findings. Interestingly, the multipliers with respect to skills are close to the multipliers with respect to employment status. Every new skilled tradable jobs generates 19.5 nontradable jobs. Contrastingly, every unskilled tradable jobs generates 12 nontradable jobs. A possible explanation is that the employment status is simply a mirror of the skills. Since wages are increasing with employment status and/or skills, these results are indirect evidence

Table 6. Local multipliers w.r.t. employment status and skills

	ols	iv	ols	iv	ols	iv	ols	iv
	$\Delta N^{NT}_{m,t}$		$\Delta N^{NT}_{m,t}$		$\Delta N^{NTES}_{m,t}$		$\Delta N^{NTSE}_{m,t}$	
$\Delta N^{TES}_{m,t}$	10.87***	20.96***						
	(1.27)	(4.17)						
$\Delta N^{TSE}_{m,t}$			12.83***	8.21***				
			(1.20)	(1.23)				
$\Delta N^{T}_{m,t}$					3.89***	4.82***	2.09***	2.01***
					(0.30)	(0.72)	(0.17)	(0.40)
N	376	209	388	391	404	390	399	386
	$\Delta N^{NT}_{m,t}$		$\Delta N^{NT}_{m,t}$					
$\Delta N^{THS}_{m,t}$	17.42***	19.52***						
	(1.13)	(3.18)						
$\Delta N^{TLS}_{m,t}$			9.13***	11.74***				
			(0.75)	(1.76)				
N	378	321	405	379				

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. This table displays the estimation of equation 1 with respect to employment status with $\Delta N^{TES}_{m,t}$ and $\Delta N^{NTES}_{m,t}$ the change in employees in the tradable and nontradable sectors and $\Delta N^{TSE}_{m,t}$ and $\Delta N^{NTSE}_{m,t}$ the change in self-employment in the tradable and nontradable sectors as well as with respect to skills with $\Delta N^{THS}_{m,t}$ and $\Delta N^{TLS}_{m,t}$ the change in high skills and low skills employment in the tradable sector. Standard errors are in parenthesis. N is the number of geographic units in the regression.

of the importance of the demand for locally produced goods to explain the size of the multiplier.

An alternative explanantion to account for the size of the multiplier is that jobs created in the nontradable sector are mostly informal jobs. Estimating the multiplier with respect to the employment status of the jobs created indicates that tradable jobs are associated with nontradable employees jobs rather than nontradable self-employed jobs. This result is in line with the reduction in the overall number of self-employment in Rwanda. It is also indicative that the size of the multiplier is not the result of the type of jobs created, many informal jobs rather than fewer formal jobs.

In the appendix, Tables 10 and 11 display robustness check i) including a constant term ii) excluding a constant term but controlling for size. The results hold across the different estimations.

5. Conclusion

In this paper, we assess the job creation potential of sectoral policies in Rwanda applying a novel methodology based on the latest development in urban economics. The innovation is to use the employment, the sectoral and the geographic information contained in censuses as well as to measure sectoral employment at the local level.

Our main result is a clear hierarchy between tradable sectors, nontradable sectors and agriculture. We find that the tradable sector displays the largest employment potential as 1 job created in the tradable sector generates 6 to 7 jobs in the local economy. Contrastingly, the local multiplier associated with the nontradable sector is positive but moderate in size. The main reason is that job creation in a given non-

tradable subsector only stimulates employment in other nontradable subsectors via the consumption of locally produced goods. Contrastingly, tradable goods are consumed and produced in different geographic locations. In addition, the multiplier associated with agriculture is negative as Rwanda is experiencing a shift away from subsistence farming and as the consumption of locally produced agriculture goods follow the Engel's law.

This paper also highlights the contribution of this methodological approach to the understanding of sectoral employment by comparing local multipliers with IO based employment multipliers. IO employment multipliers produce a different hierarchy as multipliers are the highest in sectors with low productivity in the supply chain such as agriculture. It follows that the multiplier of tradable and nontradable on agriculture is relatively large, although in reality an increase in the demand for agriculture goods is most likely to be met by an increase in productivity rather than an increase in labor inputs. Additionally, the multiplier of tradable on nontradable is small in comparison as IO based multipliers fail to capture economic behaviour such as the demand for locally produced goods. These shortcomings could be corrected by combining the IO table with a CGE model. However, the appealing features of local multipliers is its relative simplicity.

Lastly, we show that local multipliers increase with the skills level and with the employment status. We interpret this result as indirect evidence of the importance of the demand for locally produced goods. To conclude, one limitation of the methodlogy proposed in this paper is that the disaggregation at the local level restricts sectoral disaggregation in particular in countries with a homogenous sectoral specialization as it is the case in Sub-Saharan African countries.

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A. Local multiplier: robustness check

Table 7. Local multipliers for aggregated sectors - with a constant term

	ols	iv	ols	iv	ols	iv	ols	iv
	$\Delta N^{NT}_{m,t}$				$\Delta N^{A}_{m,t}$			
$\Delta N^{T}_{m,t}$	6.56***	5.59***			-0.65	-0.58		
	(0.63)	(1.50)			(0.41)	(0.79)		
N	407	394			404	391		
			$\Delta N^{T}_{m,t}$		$\Delta N^{A}_{m,t}$			
$\Delta N^{NT}_{m,t}$			0.09***	0.05***	-0.08*	0.006		
			(0.01)	(0.02)	(0.05)	(0.04)		
N			407	407	413	416		
	$\Delta N^{NT}_{m,t}$		$\Delta N^{T}_{m,t}$					
$\Delta N^{A}_{m,t}$	-0.053	3.59***	-0.005	0.17				
	(0.04)	(1.06)	(0.004)	(0.13)				
N	413	416	404	391				
								$\Delta N^{T1}_{m,t}$
$\Delta N^{T2}_{m,t}$							0.48***	0.76***
							(0.10)	(0.18)
N							380	350

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. This table presents the results of the estimation of equation 1 and equation 2 with a constant term. Equation 1 is estimated for the different combinations between tradable $\Delta N^{T}_{m,t}$, nontradable $\Delta N^{NT}_{m,t}$ and agriculture $\Delta N^{A}_{m,t}$. The table includes both the ols estimation and the instrumental variable estimation. Standard errors are in parenthesis. N is the number of geographic units in the regression.

Table 8. Local multipliers for aggregated sectors - controlling for size

	ols	iv	ols	iv	ols	iv	ols	iv
	$\Delta N^{NT}_{m,t}$				$\Delta N^{A}_{m,t}$			
$\Delta N^{T}_{m,t}$	6.5***	5.45***			-0.68*	-0.62		
	(0.61)	(1.52)			(0.42)	(0.81)		
$X_{m,t-1}$	0.24	2.46***			-1.11*	-1.62*		
	(0.37)	(0.59)			(0.59)	(0.69)		
N	407	394			404	391		
			$\Delta N^{T}_{m,t}$		$\Delta N^{A}_{m,t}$			
$\Delta N^{NT}_{m,t}$			0.08***	0.042***	-0.09*	0.014		
			(0.009)	(0.016)	(0.054)	(0.039)		
$X_{m,t-1}$			0.30***	0.56***	-1.26**	-1.74***		
			(0.043)	(0.049)	(0.57)	(0.57)		
N			407	394	413	416		
	$\Delta N^{NT}_{m,t}$		$\Delta N^{T}_{m,t}$					
$\Delta N^{A}_{m,t}$	-0.05	2.89***	-0.005	0.11				
	(0.04)	(0.97)	(0.004)	(0.107)				
$X_{m,t-1}$	4.87***	10.07***	0.72***	0.91***				
	(0.41)	(2.06)	(0.05)	(0.22)				
N	413	416	404	391				
								$\Delta N^{T1}_{m,t}$
$\Delta N^{T2}_{m,t}$							0.47***	0.75***
							(0.10)	(0.18)
$X_{m,t-1}$							0.24***	0.26***
							(0.03)	(0.04)
N							380	350

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. This table presents the results of the estimation of equation 1 and equation 2 excluding the constant term and including the population of the geographic entity in the last period $X_{m,t-1}$. The table includes both the ols estimation and the instrumental variable estimation. Standard errors are in parenthesis. N is the number of geographic units in the regression.

Table 9. Local multipliers for aggregated sectors - controlling for size and agriculture

	ols	iv	ols	iv
	$\Delta N^{NT}_{m,t}$		$\Delta N^{T}_{m,t}$	
$\Delta N^{T}_{m,t}$	6.5***	4.6***		
	(0.61)	(1.44)		
$\Delta N^{NT}_{m,t}$			0.08***	0.05***
			0.009)	(0.016)
$X_{m,t-1}$	0.19	5.59***	0.29***	0.20
	(0.38)	(1.99)	(0.043)	(0.19)
$N^{A}_{m,t-1}$	-0.022	1.53*	-0.0004	-0.19
	(0.021)	(0.90)	(0.002)	(0.086)
N	404	394	404	407

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. This table presents the results of the estimation of equation 1 excluding the constant term and including the population of the geographic entity in the last period $X_{m,t-1}$ and agriculture employment level in the last period $N^{A}_{m,t-1}$. Equation 1 is only estimated for tradable $\Delta N^{T}_{m,t}$ and nontradable $\Delta N^{NT}_{m,t}$ sectors. The table includes both the ols estimation and the instrumental variable estimation. Standard errors are in parenthesis. N is the number of geographic units in the regression.

Table 10. Multipliers w.r.t. employment status - with a constant term

	ols	iv	ols	iv	ols	iv	ols	iv
	$\Delta N^{NT}_{m,t}$		$\Delta N^{NT}_{m,t}$		$\Delta N^{NTES}_{m,t}$		$\Delta N^{NTSE}_{m,t}$	
$\Delta N^{TES}_{m,t}$	9.51***	10.42***						
	(1.54)	(3.80)						
$\Delta N^{TSE}_{m,t}$			11.63***	5.92***				
			(1.58)	(1.69)				
$\Delta N^{T}_{m,t}$					3.95***	3.92***	1.90***	0.72
					(0.39)	(0.92)	(0.22)	(0.48)
N	376	209	388	391	404	390	399	386
	$\Delta N^{NT}_{m,t}$		$\Delta N^{NT}_{m,t}$					
$\Delta N^{THS}_{m,t}$	16.01***	12.12***						
	(1.35)	(3.91)						
$\Delta N^{TLS}_{m,t}$			8.68***	9.04***				
			(1.04)	(2.25)				
N	378	321	405	379				

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. This table displays the estimation of euqation 1, including a constant term, with respect to employment status with $\Delta N^{TES}_{m,t}$ and $\Delta N^{NTES}_{m,t}$ the change in employees in the tradable and nontradable sectors and $\Delta N^{TSE}_{m,t}$ and $\Delta N^{NTSE}_{m,t}$ the change in self-employment in the tradable and nontradable sectors as well as with respect to skills with $\Delta N^{THS}_{m,t}$ and $\Delta N^{TLS}_{m,t}$ the change in high skills and low skills employment in the tradable sector. The table includes both the ols estimation and the instrumental variable estimation. Standard errors are in parenthesis. N is the number of geographic units in the regression.

Table 11. Multipliers w.r.t. employment status - controlling for size

	ols	iv	ols	iv	ols	iv	ols	iv
	$\Delta N^{NT}_{m,t}$		$\Delta N^{NT}_{m,t}$		$\Delta N^{NTES}_{m,t}$		$\Delta N^{NTSE}_{m,t}$	
$\Delta N^{TES}_{m,t}$	9.62***	10.26***						
	(1.57)	(3.87)						
$\Delta N^{TSE}_{m,t}$			11.47***	5.76***				
			(1.56)	(1.72)				
$\Delta N^{T}_{m,t}$					3.90***	3.85***	1.88***	0.64
					(0.38)	(0.92)	(0.22)	(0.50)
$X_{m,t-1}$	1.63***	4.89***	1.23***	2.34***	-0.033	1.04***	0.38***	1.49***
	(0.47)	(0.76)	(0.47)	(0.68)	(0.24)	(0.34)	(0.12)	(0.21)
N	376	209	388	391	404	390	399	386
	$\Delta N^{NT}_{m,t}$		$\Delta N^{NT}_{m,t}$					
$\Delta N^{THS}_{m,t}$	15.93***	11.62***						
	(1.33)	(4.01)						
$\Delta N^{TLS}_{m,t}$			8.56***	9.01***				
			(1.03)	(2.25)				
$X_{m,t-1}$	1.35***	3.20***	0.69	2.01***				
	(0.29)	(0.67)	(0.50)	(0.51)				
N	378	321	405	379				

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. This table displays the estimation of euqation 1, excluding the constant term and including the population of the geographic entity in the last period, with respect to employment status with $\Delta N^{TES}_{m,t}$ and $\Delta N^{NTES}_{m,t}$ the change in employees in the tradable and nontradable sectors and $\Delta N^{TSE}_{m,t}$ and $\Delta N^{NTSE}_{m,t}$ the change in self-employment in the tradable and nontradable sectors as well as with respect to skills with $\Delta N^{THS}_{m,t}$ and $\Delta N^{TLS}_{m,t}$ the change in high skills and low skills employment in the tradable sector. The table includes both the ols estimation and the instrumental variable estimation. Standard errors are in parenthesis. N is the number of geographic units in the regression.

Table 12. Tradable on other tradable random grouping

Random split	(1) OLS	(2) IV	(4) N
group 1	0.12***	0.01	335
group 2	0.20***	0.05	251
group 3	0.27***	0.43***	336
group 4	0.66***	2.58***	219
group 5	0.34***	0.66***	353

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

B. Input-output analysis

B.1 Data source

Two input-output tables are available for Rwanda for the years 2006 and 2011 (see Xinshen (2012) as well as (Pradesha and Diao, 2014)). There are two input-output tables for 2006. The first table has been produced by Emini (2007) as the outcome of a project between the ministry of finance (MINECOFIN) in collaboration with the ministry of agriculture (MINAGRI) and the World Bank. Based on the table produced by Emini (2007), Xinshen (2012) proposed a disaggregation of the households' accounts with respect to 30 districts as well as with respect to rural and urban. The input-output table for 2006 is made of 51 sectors with a particular focus on the agriculture sector, which is decomposed into 25 subsectors. The tradable sector is made of 11 sectors (excluding water and electricity production and construction) and the nontradable sector is made of 14 sectors. In the 2011 input-output table, there are 54 sectors. The three new sectors are pyrethrum, and the disaggregation of "Bakery, processed coffee, tea and sugar" into "Processed coffee", "Processed tea" and "Bakery, processed sugar" to better reflect the importance of the coffee and tea supply chain in Rwanda. Importantly, the input-output coefficients for the 2011 table are based on those in the 2006 tables. It follows that the multipliers are similar for both years.

B.2 Overview of input-output analysis

The overview of input-output is based on Miller and Blair (2009). The input-output table describes the sectoral composition of an economy and informs about the inter-relation between the different sectors of the economy. An input-output table presents itself as a square matrix M. The number of rows and columns of the matrix corresponds to the number of sector in the economy.

$$A = \begin{bmatrix} A_{11} & A_{12} & ... & A_{1n} \\ A_{21} & A_{22} & ... & A_{2n} \\ \vdots & \vdots & & \vdots \\ A_{n1} & A_{n2} & ... & A_{nn} \end{bmatrix}$$

The table can be read vertically, each column corresponding to a sector j of the economy. For a given column j, each element of the column indicates the quantity of goods from other sectors of the economy used as input in the production process of sector j. For instance, looking at column 2, A_{12} indicates the quantity of goods from sector 1 necessary for the production of sector 2. A_{22} is the quantity of sector 2 necessary for its own production. It follows that the input-output table gives a detailed overview of the inter-linkages between the different sectors. Depending on the domestic supply-chains, and depending on the degree of openness of the economy, the input-output table can be used to indicate, which sectors are likely to generate the highest increase in domestic production.

The input-output table is often represented in the form of an expanded flow table as in Table 13 for instance. The expanded table combines the input-output matrix just presented with the income side and expenditure side of the national account. On the income side, the production in sector j is the sum of the intermediate consumptions A_{ij}, the payments to capital K_j and labour inputs N_j and payments to imported intermediate consumption M_j.

Table 13. Expanded flow table

	Processing sectors				Final demand				Total output
Sectors	A_{11}	A_{12}	...	A_{1n}	C_1	I_1	G_1	E_1	X_1
	A_{21}	A_{22}	...	A_{2n}	C_2	I_2	G_2	E_2	X_2
	$\vdots$	$\vdots$		$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$	$\vdots$
	A_{n1}	A_{n2}	...	A_{nn}	C_n	I_n	G_n	E_n	X_n
Payments	K_1	K_2	...	K_n					K
	N_1	N_2	...	N_n					N
	M_1	M_2	...	M_n					M
Total outlays	X_1	X_2	...	X_n	C	I	G	E	X

$$X_j = \sum_{i=1}^{n} A_{ij} + K_j + N_j - M_j \tag{5}$$

On the demand side, production in sector i is given by the sum of the demand from other sectors A_{ij} plus final demand of goods produced in sector i in the form of consumption C_i, investment I_i, government consumption G_i, and exports E_i.

$$X_i = \sum_{j=1}^{n} A_{ij} + C_i + I_i + G_i + E_i \tag{6}$$

From the expanded tables, it is possible to compute the ratio of input to output a_{ij}, also called the technical coefficient or input-output coefficient. This ratio is given by the quantity of input A_{ij} from sector i necessary for the production of sector j divided by the production X_j of sector j. The coefficient a_{ij} indicates the amount of intermediate consumption from sector i necessary to produce one unit of goods from sector j.

$$a_{ij} = \frac{A_{ij}}{X_j} \tag{7}$$

This ratio makes implicit assumptions regarding the production function of an economy. The production function is said to have fixed coefficients. The increase in production of sector j will always be met by a proportional increase in the inputs from different sectors irrespective of the change in the relative price of the inputs. Additionally, the production function is said to have constant return to scale. An increase in the scale of production does not take place with an improvement in the production process and a diminution of the inputs required.

Eq 5 and 6 can now be rewritten as follow:

$$X_j = \sum_{i=1}^{n} a_{ij} X_j + K_j + N_j - M_j \tag{8}$$

$$X_i = \sum_{j=1}^{n} a_{ij} X_j + Y_i \tag{9}$$

Table 14. Production multipliers

2006		2011	
Sectors	m_p	Sectors	m_p
Coffee	1.1	Coffee	1.2
Green tea	1.7	Green tea	1.3
		Pyrethium	1.2
Mining	1.6	Mining	1.5
Processed coffee tea sugar bakery	1.9	Processed coffee	2.2
		Processed tea	1.7
Textile and clothing	2.1	Textile and clothing	2.1
Wood, paper and printing	1.9	Wood, paper and printing	1.9
Non-metalic minerals	1.8	Non-metalic minerals	1.8
Furniture and other manufactured products	2.0	Furniture and other manufactured products	2.0
Construction	1.8	Construction	1.8
Hotels and restaurants	2.0	Hotels and restaurants	2.0
Transports	1.8	Transports	1.8

This table summarizes the production multipliers corresponding to the IO table 2006 and 2011. The multiplier is the percentage change in total production following a 1% of GDP shock on the corresponding sector.

with Y_i demand for sector i the sum of the different demand components $C_i + I_i + G_i + E_i$. Rewritting eq 9 in the form of vectors and matrix, we get the following equation:

$$X = aX + Y \tag{10}$$

Given the matrix of technical coefficient a, an increase in the vector of final demand Y, will generate an increase in the sectors' production X given by the solution to this equation:

$$X = (1 - a)^{-1}Y \tag{11}$$

There is a solution if the matrix $(1-a)$ can be inverted (if $|1-a| \neq 0$). $(1-a)^{-1}$ is called the Leontieff inverse. From these simple relationships, it is possible to identify the sectors that are likely to generate the largest increase in overall production through the sectoral interlinkages. In this perspective, IO analysis can contribute to the formulation of sectoral policies and economic development policies.

Table 14 shows the production multipliers for both 2006 and 2011. The multipliers are identical, which is consistent with the fact that the 2011 input-output is based on the 2006 input-output table. The small differences are explained by rounding numbers or by changing industrial classification. Regarding the agriculture sector, pyrethrum did not appear as a subcategory. Similarly, processed coffee and tea were treated in the same category in 2006 while coffee and tea were treated in distinct categories in 2011.

B.3 Constructing employment satellite account in EICV III

This section describes sectoral employment based on EICV III as well as how sectors are matched with the input-output sectors. EICV III is a household's database. 14308 households were interviewed for the EICV III survey, which corresponds to 56116 individuals. The geographic coverage is national with representative households sampled at provincial and district levels. The EICV III database enables households to report about multiple activities. Each activity is classified into 4 categories:

1. waged or salaried employment (farm and non farm)
2. VUP activities
3. independent farmer, unpaid family farm worker; non-farm family unpaid worker, other non-paid work
4. independent non-farm (which corresponds to domestic work i.e. not domestic worker)

For each of the three categories there is a corresponding sub questionnaire that includes sectoral information: 24, 6 and 27 sectoral activities respectively. The "independent non-farm" category describes domestic work such as time use foraging for firewood, searching for fodder or grazing, fetching water, going to the market, cooking, laundry, cleaning etc... These activities are not market activities and are therefore excluded as no corresponding categories exist in the IO table.

In the questionnaire, each respondent indicates the number of economic activity and the seasonality of each activity. Additional respondents indicate the number of months, the number of days per month and the number of hours per day spent on each activity. This enables us to compute total hours worked for each sectoral activity.

Table 15 describes the sectoral production reported by the 2011 IO table, total hours worked per sector computed using EICV III and how the two data sources are matched together. Regarding sectoral classification, there are differences regarding the sectors. In a first step, while the IO table has a detailed description of 26 agriculture subsectors, EICV III only reports 4 sectors: agriculture, livestock, forestry, fishing and hunting. Similarly, food manufacture is decomposed into its various subcomponent to keep track of the tea and coffee supply chains. However, only the hours worked at the aggregate sector is reported in EICV III. On the contrary, while EICV III decomposes total hours worked for various construction subsectors (buildings, roads and rural), the IO table does not make such a distinction. There are sectoral mismatches when it comes to the different services sectors. These mismatches are hard to reconcile and strong assumption are made. In EICV III, "imports and exports" is aggregated with "hotels and restaurants", while "Recreation and tourism" is aggregated with "Domestic services". Similarly, "repair" is merged with "Business services" in the IO table. These strong assumptions have little impact overall given the sectoral mismatch concerns relatively small sectors in terms of production and employment.

In order to compute a measure of labour productivity, total hours worked is divided by sectoral production. Sectoral production is taken from the IO table tables and is defined as intermediate consumption plus value added (intermediate consumption plus factor incomes); X_j in eq 5. Labour productivity is the smallest in the agriculture subsectors as well as in "domestic services". The latter aggregates both "Other community, social and personal service activities" as well as "Activities of private households as employers and undifferentiated production activities of private households".

Table 15. Sectoral classification and labour productivity

IO table 2011		EICV III		Common classification	
sectors	production	sectors	total annual hours	sectors	productivity
Wheat	19102	Agriculture	5.45E+09	Agriculture	0.02
Maize	123641				
Paddy rice	38750				
Sorghum	59473				
Irish potatoes	127036				
Sweet potatoes	115558				
Cassava	98179				
Other roots	11550				
Pulses	199800				
Other vegables	108098				
Bananas	152393				
Other fruits	23386				
Oil seed	65619				
Coffee	18588				
Green tea	20308				
Pyrethium	1440				
Other export crops	1024				
Bovine cattle	29553	Livestock	2.26E+08	Livestock	0.03
Sheep and goats	4052				
Swine	2579				
Poultry	3352				
Raw milk	16672				
Eggs	2870				
Other livestock products	2494				
Forestry	86625	Forestry	2.62E+07	Forestry	0.33
Fishing	18334	Fishing & Hunting	1.97E+07	Fishing & Hunting	0.09
Mining	73378	Mining	4.63E+07	Mining	0.08
		Quarrying	46700000		
Meat, fish and dairy products	85729	Food Manufacture	5.51E+07	Food Manufacture	1.07
Processed cereals	63794				
Processed coffee	53099				
Processed tea	93749				
Bakery, processed sugar	13059				
Traditional beverages	210457				
Modern beverages	59468				
Tobacco	10800				
Textile and clothing	36937	Textile Manufacture	1.74E+07	Textile Manufacture	0.21
Wood, paper and printing	21356	Wood Products Man.	3.87E+07	Wood, paper and printing	0.05
		Paper Products Man.	6514635		
Chemicals	29607	Chemicals	6271618	Chemicals	0.47
Non-metalic minerals	39462	Non-metallic Products. Man.	5616347	Non-metallic Products. Man.	0.70
Furniture and other	51270	Metal Manufacture	464642.2	Furniture and	
manufactured products		Metal Products Man.	1.24E+07	other manufactured products	0.40
Electricity, gas and water	19876	Electricity, gas and water	2.40E+07	Electricity, gas and water	0.08
Construction	668026	Construction Buildings	3.62E+08	Construction	0.16
		Construction Roads	2.64E+07		
		Rural Reconstruction	3.49E+07		
Wholesale and retail trade	550430	Wholesale Trade	6.73E+07	Wholesale and retail trade	0.21
		Retail Trade	1.90E+08		
		Other Trade	1481275		
Hotels and restaurants	170688	Hotel & restaurants	9.08E+07	Hotel & restaurants	0.18
		Import & Export	1648822		
Transports	363528	Transport	1.35E+08	Transports	0.25
		Warehousing	1.17E+07		
Communication	137141	Communications	1.36E+07	Communications	1.01
Finance and insurance	133426	Banking	2.09E+07	Finance and insurance	18272
		Insurance	3480448		
Real estate	195721	Real Estate	1723529	Real Estate	11.36
Business services	94145	Business Services	1.66E+07	Business Services	0.87
Repair	49946				
Public administration	357408	Government, Admin	5.37E+08		0.14
Education	295665	& Social Services			
Health	78151				
		Recreation & Tourism	1.30E+07		
Other personal services	42340	Domestic Services	4.69E+08		0.01

This table presents the industrial classification related to the IO table 2011, the EICV III and how the two classifications are matched together to compute the ratio of total hours worked to production (measured in millions of FRW). Productivity is multiplied by 100 for presentation purpose.

Productivity is the highest in the manufacturing sectors such as “food manufacture” or “Non-metallic Products Manufacture”. An exception is “Wood, paper and printing”. In the service sectors, productivity is intermediate relatively to agriculture and manufacture to the exception of “Finance”, “Communication” and “Real estate”.

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ISSN 2519-4941