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Optimal Locational Choice for Agrobusinesses in Madagascar

An Application of Spatial Autoregressive Tobit Regression

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Abstract

The traditional location theory predicts that firms' locational choice is independent of the output demand. However, firms are often concentrated in large markets. In Africa, agrobusinesses are expected to play an important role to facilitate agricultural growth but are hardly available in rural areas. This paper examines the question of why agribusinesses are not located in local production areas despite the clear benefits expected from close proximity to their inputs. By applying the spatial autocorrelation Tobit model, the paper estimates the impacts of market and farm accessibility on agglomeration of new agrobusinesses in Madagascar. The findings show that market accessibility and agglomeration economies are important for attracting more agrobusinesses. The quality of labor is also an important determinant for their locational choice. The findings are consistent with some models of location theory: firms move away from rural areas where they may still have monopsony power, toward urban areas where productivity is higher.

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Optimal Locational Choice for Agrobusinesses in Madagascar: An Application of Spatial Autoregressive Tobit Regression

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Key words: Location theory; Agglomeration economies; Spatial autocorrelation; Censored regression.

JEL classification: H54; H41; R32; C21; C26.

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I. INTRODUCTION

Agrobusinesses, such as input suppliers, collectors, processors and exporters, play an important role to facilitate agricultural growth in many developing countries (e.g., World Bank, 2013). Especially in Africa where the production system remains largely subsistence farming, a large number of rural farmers live under the poverty line and do not have their own transport means. To purchase advanced inputs, such as fertilizer and improved seeds, and access the output market to sell harvested crops, transportation services must of necessity be provided by agribusinesses or trucking companies. Unavailability of affordable transportation has been recognized as one of the significant constraints in many African countries (Teravaninthorn and Raballand, 2009). In Ethiopia, for instance, transport costs account for 64-80 percent of fertilizer farmgate prices (Rashid et al. 2013).

Despite its clear importance, agrobusiness is still hardly available to many farmers in Africa. First of all, regardless of sectors, the formal private sector remains generally thin in the region. This is not a unique problem for the agrobusiness industry. Even though there are some agrobusinesses in a country, they are often only located in major urban areas or even abroad. In Rwanda, for instance, 47 percent of agrobusinesses are located at the primary city, Kigali, while about 90 percent of the country's total population live elsewhere (Iimi et al., 2015). While West African countries account for about 70 percent of the global cocoa production, the EU accounts for 40 percent of the world's cocoa processing from cocoa beans to cocoa paste and butter (World Bank, 2013). A natural question is why agribusinesses are not located in local production areas despite clear benefits from close proximity to their inputs.

The economics literature has long been discussing where a firm should be located. In general, the traditional location theory initiated by Moses (1958) suggests that the optimal location of a firm can be determined by the production and demand functions and transportation rates of inputs and outputs. One of the major conclusions in the early literature is that the optimal location is independent of the demand in the output market as long as the production function is linearly homogeneous (Sakashita, 1967). This holds even if the distance from the output market is a variable (Shieh, 1989). If the production function exhibits homogeneity of a degree greater than one, a firm location moves toward the output market (Khalili et al., 1974).

Various theoretical extensions followed (see McCann (1998) for a comprehensive summary). For instance, McCann (1993) shows that when logistics and inventory costs are taken into account,[1] the firm's optimal location is closer to the market as the total value added at the production point increases. That is, more valuable products are produced close to the output market. This seems to be the case of cocoa production. The results may also differ significantly if a firm has market power. Shieh and Mai (1997) show that a firm is likely to move away from its monopsonized input market because a relative transportation cost of the monopsonized input decreases, increasing the relative pull of the other input. This may be the case that many agrobusinesses are located in major cities where other inputs are available than agricultural produce.

The new economic geography literature puts more emphasis on the importance of agglomeration economies to attract firms to an industrial cluster or a city (e.g., Krugman, 1991; Fujita et al. 1999). Given the proximity, firms can expect to receive benefit from sharing the common labor and intermediate input markets and minimizing trade and transaction costs. This is empirically supported. For instance, agglomeration economies among French companies are found to be based on physical and cultural proximity (Procher, 2011). In the United States, Korean consumer goods manufacturers are spatially less concentrated, but the assembly industry is concentrated where large U.S. upstream firms exist, to take advantage of agglomeration economies (Lee et al., 2012). Mare and Graham (2013) show that agglomeration economies are also significant in New Zealand, with the elasticity estimated at 0.06.

[1] The discrete nature of delivery flows of inputs and outputs is assumed, as considered in the economic order quantity literature (e.g., Mosser, 1991; Caplin and Leahy, 2010).

The current paper examines the locational choice of agrobusinesses in Madagascar, one of the least developed countries in Africa. Of particular note, although growth in Africa has recently been accelerated, little empirical evidence is available to show firms' locational behavior. Methodologically, the paper applies the spatial autocorrelation Tobit (SPTobit) model (Shehata and Mickaiel, 2013) to address two potential empirical problems in our spatial data: (i) spillover effects across geographic locations and (ii) data skewness with a number of zeros. The paper measures a wide variety of transport accessibility, including the Market Access Index and Farm Access Index, to answer the question of where agrobusinesses should be located, and why. Detailed road network data were collected and used to generate various accessibility measurements.

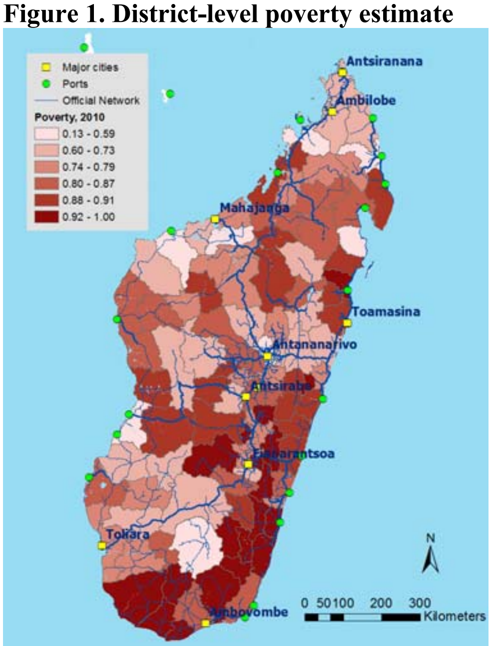
The remaining sections are organized as follows: Section II provides an overview of crop production, agrobusinesses and transport infrastructure in Madagascar. Section III develops an empirical methodology and describes our data. Section IV presents main estimation results and discusses policy implications. Then, Section V concludes.

II. AGRICULTURE, AGROBUSINESS AND ROAD NETWORK IN MADAGASCAR

Madagascar is one of the poorest countries in the world, with a total population of about 25 million. The nation's GDP per capita was about US$400 in 2016. Many people live below the poverty line. The latest available poverty rate is 71 percent for 2012 (**Figure 1**). There is significant urban-rural inequality: The poverty rate was estimated at 36 percent in urban areas and 78 percent in rural areas (World Bank, 2016). The vast majority of the rural poor engage in agricultural production. Agriculture remains an important sector, employing about 75 percent of the labor force in the country, generating 25 percent of GDP and contributing to 30 percent of the country's total goods exports. Madagascar produces not only food crops, such as rice, cassava and maize, but also vanilla, coffee and lychee. In general, however, agricultural productivity remains minimal. Along with the distorted domestic crop prices, transportation is one of the most critical constraints in the country (World Bank, 2016).

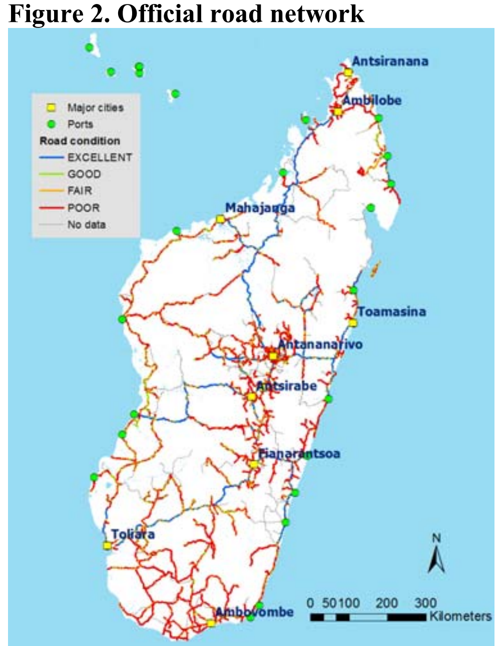
Madagascar possesses an official road network of 31,640 km, of which only about 5,600 km are paved. While about 70 percent of the paved roads are in good or fair condition, the vast majority of unpaved roads are in poor condition (**Figure 2**). Because of the poor condition of the feeder road network, people's transport mobility is extremely limited in rural areas. The Rural Access Index, which measures the share of rural population who live in within 2 km of a road in good condition, is estimated at 11.4 percent in Madagascar, leaving 17 million rural people unconnected (**Figure 3**).

Figure 1. District-level poverty estimate



Source: World Bank estimate.

Figure 2. Official road network



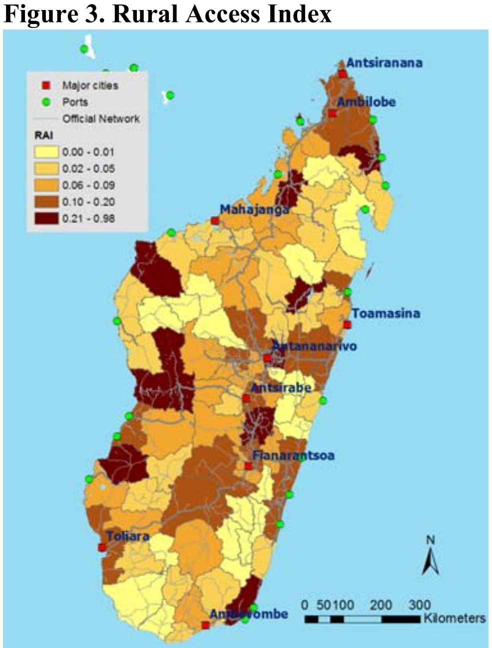
Source: Madagascar Road Authority.

According to the official firm registry database, as of 2017, there existed 1,309 agrobusinesses in the country. Output-related agrobusinesses, including large plantations, collectors, processing companies, and exporters, are dominant, which amount to 902 companies in the database. On the other hand, 399 input-related agrobusinesses, also exist, such as fertilizer and other input dealers and equipment suppliers.[2] The spatial distribution of agrobusinesses is highly skewed (**Figure 4**). Among the agribusinesses, 569 firms or nearly

[2] This classification may be ambiguous. In the database, each agrobusiness is categorized as either an input- or output-related firm based on the description of its primary business activity. In practice, however, some of them are likely to engage in both activities.

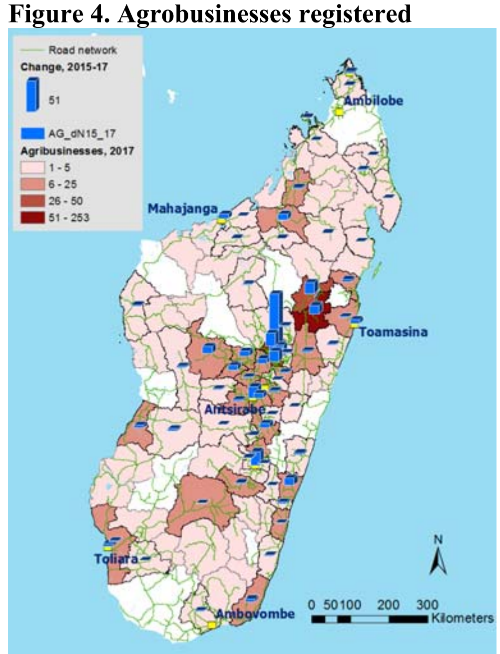
half of the total are located in three districts: Antananarivo, Fianarantsoa and Ambatondrazaka. While the first two are the largest two urban areas in the middle of the country, the last is the largest rice production area located between Antananarivo and Toamasina, the primary port city. Agrobusinesses seem to be concentrated where the road condition is relatively good and rural accessibility is broadly high.

Figure 3. Rural Access Index



Source: World Bank estimate.

Figure 4. Agrobusinesses registered



Source: Madagascar Statistical Institute.

III. Methodology and Data

To examine the firm's locational choice in connection to site-specific characteristics, the following simple equation is considered:

$$\Delta N_i = X_i \beta + \gamma_1 N_i + \gamma_2 ALLN_i + u_i \quad (1)$$

Our dependent variable, ΔN_i, is the number of agrobusinesses established at commune i during a particular period. This is assumed to be dependent on location-specific characteristics, including the number of existing firms (i.e., agglomeration economies). To mitigate the risk of endogeneity, though it is difficult to avoid it completely (e.g., Graham et al., 2010), the lagged values are used to measure thickness of the existing industry. Two types of agglomeration are considered: the number of other agrobusinesses, N_i, and the number of all firms registered, $ALLN_i$. While the former is often referred to as localization economies, the latter is called urbanization economies. *X* contains other location-specific characteristics, including transport connectivity.

There are at least two important empirical issues to estimate Equation (1). First, spatial autocorrelation matters. Especially, our primary interest is the impacts of transport connectivity on firms' agglomeration. Agglomeration economies would likely spill over. If firms are concentrated at a particular location, neighboring areas may also benefit from it. In addition, transport infrastructure is by nature a network industry. All firms are somehow connected to each other, but the connectivity must be dependent on the condition of the underlying infrastructure. Therefore, any observation may not be independent of another, i.e., $Cov(u_t, u_s) \neq 0$.

Second, our dependent variable is left-censored at zero because there are many communes where no agrobusiness exists. This is a typical empirical issue with spatial data (e.g., Agarwal et al., 2002; Lee et al., 2016). In our data, 410 agrobusinesses were newly registered for the last three years: 2015-17. To avoid any possible effect of geographically biased events, the total number for three years is used. These firms are located at 142 communes of a total of 1,549 communes in Madagascar. Thus, the dependent variable has an excessive number of zeros.

To deal with these two problems, the spatial Tobit (SPTobit) regression model is used. Denoting the latent variable of the output produced by *ΔN**, our censoring mechanism is this:

$$\Delta N_i = \begin{cases} \Delta N_i^* & if\ \Delta N_i^* > 0 \\ 0 & Otherwise \end{cases} \tag{2}$$

Where $\Delta N_i^* = \lambda \sum_j w_{ij} \Delta N_j^* + X_i \beta + \gamma_1 N_i + \gamma_2 ALLN_i + \rho \sum_j w_{ij} u_j + \varepsilon_i$

w is an element of the spatial-weighting matrix. λ and ρ are spatial autoregressive parameters in the dependent variable and error term, respectively. ε is an idiosyncratic error distributed independently and identically. Under the normality assumption, this can be estimated by the conventional maximum likelihood estimation procedure (e.g., Anselin, 1988; Amaral and Anselin, 2011; Shehata and Michaiel, 2013).

For the spatial weighting matrix, inverse distances between two locations *s* and *t* are used. The distance is calculated using the Euclidean distance between the two locations. The intuition is that two locations are more closely related to each other if they are located closely. This follows the Tobler's first law of geography: "everything is related to everything else, but near things are more related than distant things" (Tobler 1970).

For transport connectivity, three indices are generated using spatial data and software: (i) Market Access Index (*MAI*), (ii) Farm Accessibility Index (*FAI*), and (iii) Port Accessibility Index (*PAI*). The MAI is primarily expected to measure the economic proximity of each agrobusiness to the output market, which is formally defined by the following equation:

$$MAI_i = \left(\sum_k y_k / d_{ik}\right) / \max_i MAI_i \qquad (3)$$

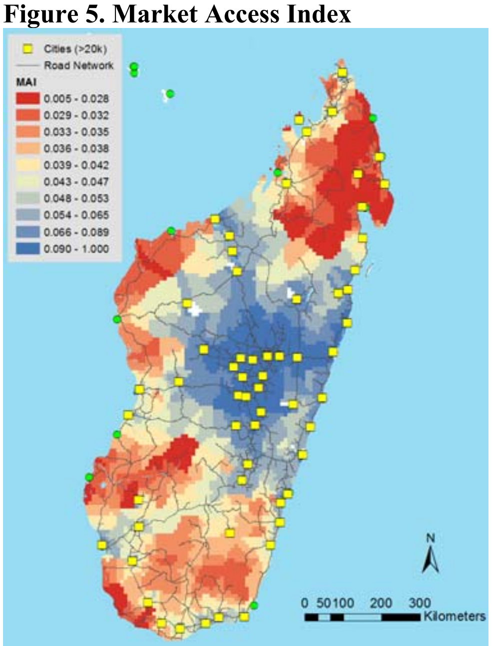
This is the sum of purchasing power or market capacity, y, inversely weighted by the degree of impediment between two locations, d.[3] For y, the city population is used as a proxy of the market capacity. d is measured by estimating transportation costs from commune i and large city k.[4] Given the georeferenced road condition data, transport costs to bring one unit of goods to a major market are calculated by spatial software minimizing the total road user costs. In principle, the costs would likely be higher when the road distance is longer and the condition is poor. The index is normalized to zero to one. The MAI clearly shows that in

[3] This is based on a conventional gravity framework. The literature also uses the negative exponential weights. See for instance Elbadawi, Mengistae and Zeufack (2006) and Lall and Mengistae (2005).
[4] In this paper, 60 cities and towns that have more than 20,000 population are considered.

Madagascar, the north and the south are disconnected to the primary domestic market, Antananarivo (**Figure 5**).

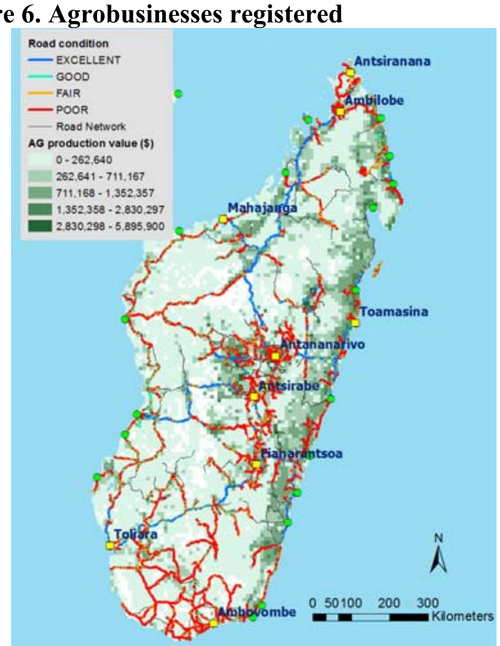
Using the same technique, the firm's proximity to farms is also measured. For *y*, a spatial crop production allocation model (SPAM), developed by the International Food Policy Research Institute (IFPRI), is used to identify the crop production value and location. The SPAM is a global production allocation model that disaggregates production data of 42 crops at a spatial resolution of 10km x10km pixel.[5] For Madagascar, there are 7,681 pixels, for each of which the total value of crop production is assigned (**Figure 6**). For *d*, the same transport cost concept is used as above. Transport costs are estimated from each agrobusiness to these production pixels. Then, the inversely weighted average is taken.

Figure 5. Market Access Index



Source: World Bank estimate.

Figure 6. Agrobusinesses registered



Source: SPAM 2005.

For port accessibility, five major ports are taken into account: Toamasina, Antsiranana, Mahajanga, Toliary and Taolagnaro. The port traffic is used as the absorption capacity for *y*

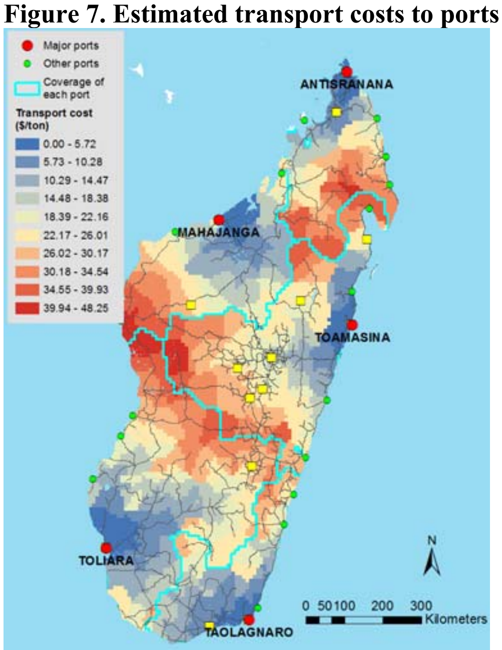
[5] It is available on the Internet at MapSpaM.info. See You and Wood (2006) and You *et al.* (2009) for details.

(**Table 1**). The transport costs to the ports vary (**Figure 7**) and are estimated from each agrobusiness to each of the ports. This is used as an impediment factor for *PAI*.

Table 1. Port traffic, 2015

Port	General cargo (mil tons)	Containerized (mil TEU)
Toamasina	0.420	0.191
Antsiranana	0.063	0.008
Mahajanga	0.044	0.011
Toliary	0.028	0.008
Taolagnaro	0.075	0.005

Figure 7. Estimated transport costs to ports



Source: World Bank estimate.

The summary statistics are shown in **Table 2**. Besides the above-mentioned accessibility indices, the local population size at the commune level is included in *X*. This aims at controlling for the size effect: The larger communes, the more agrobusinesses, regardless of any other condition. To control for heterogeneity in the local labor market, the average wage and education levels are included, which are estimated based on a recent household survey.[6] In theory, firms prefer to be located where wages are low, if everything else is the same.

[6] Enquete Periodique Aupres des Menages 2010.

Firms may also look at the quality of labor. The average household wage and the average educational attainment of household heads are computed at the district level.

In addition, the availability of other infrastructure is also taken into account: Agrobusinesses may need not only transport connectivity but also other infrastructure services, such as electricity, water and ICT. Based on the same data source, the shares of households using these infrastructure services are calculated as proxies, though firms are normally considered to have better access to infrastructure services than households.

Table 2. Summary statistics

Variable	Abb.	Obs	Mean	Std.Dev.	Min	Max
Number of agribusinesses that were established at commune *i* during 2015-17	ΔN	1,549	0.243	1.413	0	33
Market access index (0 to 1)	MAI	1,549	0.020	0.047	0.004	1.000
Port accessibility index (0 to 1)	PAI	1,549	0.051	0.061	0.016	1.000
Farm accessibility index (0 to 1)	FAI	1,549	0.028	0.043	0.009	1.000
Number of agribusinesses that already existed at commune *i* before 2014	N	1,549	0.499	2.571	0	41
Number of enterprises that already existed at commune *i* before 2014	ALLN	1,549	49.689	307.927	0	6642
Population estimate at commune *i* (million)	POP	1,549	0.015	0.023	0.0002	0.504
Average educational attainment of household heads (years)	EDU	1,549	3.956	1.509	0.000	8.336
Average household annual wage income from the primary and secondary activities (million Ariary)	WAGE	1,549	0.619	0.255	0.195	1.539
Average share of households who own the following item at district level:						
Mobile phone (0 to 1)	MOBL	1,549	0.293	0.175	0.000	1.000
Computer (0 to 1)	PC	1,549	0.012	0.020	0.000	0.122
Tap water or wells (either private or public) (0 to 1)	WATR	1,549	0.496	0.252	0.000	1.000
Electricity for lighting (0 to 1)	POWR	1,549	0.160	0.153	0.000	0.818
Pour flush or pit latrine (0 to 1)	LATR	1,549	0.408	0.296	0.000	1.000

IV. Main Estimation Results

The main estimation results are shown in **Table 3**. Although the results may be biased because the spatial autocorrelation and censoring issues are not addressed, the ordinary least squares

(OLS) regression is first performed. The results look largely consistent with economic theory. Market accessibility and agglomeration economies are found significant, indicating that more firms are attracted where market accessibility is good and other firms are also located. On the other hand, accessibility to ports and farms does not seem to be important for agrobusinesses to decide their locations. This explains why agrobusinesses are not around farmers. Comparing the importance of market and farm accessibility, the former seems to be far more critical to agrobusinesses. One of the reasons for agrobusinesses concentrating on large markets may be the better quality of labor that is available: The coefficient of *EDU* is significantly positive. Firms prefer to be located where better educated people live.

Even if the autocorrelation and censoring issues are taken into account, the results are broadly the same. The negative binomial regression (NBREG) model can control for excessive zeros in the data. Note that our dependent variable is a non-negative count data. Moreover, the SPTobit also takes the possible spatial autocorrelation into account, which is considered as the best estimator in our case. The results are found robust: Market accessibility has a positive and significant coefficient. Agglomeration economies are also always strongly positive: Firms flock together where other firms already exist. Proximity to ports and farms are not important. Education is critical to stimulate the agrobusiness industry.

The evidence seems to explain preferences of Malagasy agrobusinesses toward large urban centers. This is consistent with some models of the location theory: Agrobusinesses move toward the output market, possibly because the agrobusiness industry requires more skilled labor, possibly exhibiting a higher degree of homogeneity in their production (Khalili et al., 1974), and because the industry's competition is more intense around urban areas. On the other hand, agrobusinesses may still have monopsony power in the input market. This allows them to move further away from rural areas (Shieh and Mai, 1997).

Table 3. Estimation results with infrastructure availability variables

	OLS			NBREG			SPTOBIT		
	Coef.	Std.Err.		Coef.	Std.Err.		Coef.	Std.Err.	
MAI	4.714	(2.423)	*	2.278	(2.185)		7.780	(2.523)	***
PAI	-0.319	(0.214)		0.667	(1.208)		1.903	(1.811)	
FAI	0.325	(0.388)		2.947	(3.546)		0.969	(2.492)	
N	0.120	(0.035)	***	0.214	(0.066)	***	0.264	(0.068)	***
ALLN	0.003	(0.000)	***	0.001	(0.001)		0.002	(0.001)	***
POP	6.328	(3.209)	**	6.516	(4.985)		13.609	(8.063)	*
EDU	0.027	(0.014)	*	0.194	(0.094)	**	0.376	(0.142)	***
WAGE	-0.087	(0.069)		-0.910	(0.522)	*	-0.605	(0.604)	
MOBL	0.038	(0.135)		0.569	(1.002)		1.113	(1.337)	
PC	-3.355	(2.277)		2.671	(6.130)		4.911	(9.395)	
WATR	-0.065	(0.076)		0.115	(0.544)		-0.103	(0.675)	
POWR	0.013	(0.285)		-0.253	(1.265)		-2.176	(1.836)	
LATR	-0.196	(0.107)	*	1.002	(0.501)	**	1.319	(0.709)	*
constant	-0.038	(0.102)		-3.614	(0.566)	***	-6.425	(2.274)	***
Obs	1,549			1,549			1,549		
F statistic	19.33								
Wald chi2				133.89			2507.27		
R-squared	0.775						0.620		
Pseudo R2				0.159					
Spatial parameters:									
λ							-0.086	(0.544)	
ρ							-0.039	(0.440)	

Note: The dependent variable is ΔN. Robust standard errors are shown in parentheses. *, ** and *** indicate statistical significance at the 10, 5 and 1 percent level, respectively.

To see the relative importance of each factor, the elasticity of the number of agrobusinesses is computed by evaluating the SPTobit result at the sample means (**Table 4**). In terms of magnitude of the expected impacts, education is the most important factor to attract more agrobusinesses. The market accessibility is also among the most important determinants, followed by localization economies (*N*) and urbanization economies (*ALLN*). Both are significant. Numerically, however, agrobusinesses are more likely to flock together with other agrobusinesses rather than different industries. A policy implication is that the currently existing agrobusiness clusters would likely continue to grow further. It would be critical to develop and maintain transport infrastructure to connect them to rural areas.

Among infrastructure access variables, transport accessibility and access to improved sanitation facilities are found to be significant. While market accessibility is strongly positive, sanitation facility access has a weakly positive coefficient. The impacts of other infrastructure services are found to be insignificant. This may be an interesting finding from the public policy perspective, though the possibility that our transport accessibility variables might capture accessibility to other infrastructure services still cannot be ruled out. As long as agrobusinesses are concerned, there may be a certain rationale to prioritize transport connectivity.

Table 4. Implied elasticity based on SPTobit model

Variable	Elasticity	Std. Err.	
MAI	0.649	(0.211)	***
PAI	0.396	(0.377)	
FAI	0.112	(0.288)	
N	0.543	(0.140)	***
ALLN	0.428	(0.123)	***
POP	0.827	(0.490)	*
EDU	6.122	(2.308)	***
WAGE	-1.542	(1.541)	
MOBL	1.343	(1.614)	
PC	0.243	(0.465)	
WATR	-0.211	(1.380)	
POWR	-1.433	(1.209)	
LATR	2.218	(1.193)	*

One may think of robustness of the results against the inclusion of these infrastructure access variables. Even if these are excluded, the main estimation results are unchanged (**Table 5**): The effect of market accessibility is significantly positive, and agglomeration economies are also important. While the local education level is still important, the average wage has a negative and significant coefficient, which is consistent with economic theory. Firms prefer to locate themselves where labor inputs are cheaper. Note that the quality of labor has already been taken into account.

Table 5. Estimation results without infrastructure availability variables

	OLS			NBREG			SPTOBIT		
	Coef.	Std.Err.		Coef.	Std.Err.		Coef.	Std.Err.	
MAI	4.130	(2.129)	*	4.635	(2.329)	**	8.243	(2.560)	***
PAI	-0.462	(0.233)	**	1.028	(1.148)		1.834	(1.648)	
FAI	0.310	(0.373)		3.265	(3.983)		1.276	(2.377)	
N	0.116	(0.035)	***	0.224	(0.063)	***	0.271	(0.067)	***
ALLN	0.003	(0.000)	***	0.001	(0.001)		0.002	(0.001)	***
POP	5.947	(3.247)	*	7.881	(4.835)	*	13.953	(7.996)	*
EDU	-0.010	(0.016)		0.350	(0.070)	***	0.479	(0.101)	***
WAGE	-0.146	(0.069)	**	-1.148	(0.392)	***	-1.330	(0.517)	***
constant	0.029	(0.091)		-3.543	(0.401)	***	-5.065	(1.460)	***
Obs	1,549			1,549			1,549		
F statistic	29.09								
Wald chi2				117.85			2609.82		
R-squared	0.773						0.629		
Pseudo R2				0.154					

Note: The dependent variable is ΔN. Robust standard errors are shown in parentheses. *, ** and *** indicate statistical significance at the 10, 5 and 1 percent level, respectively.

V. Conclusion

The initial location theory suggests that the optimal location is independent of the demand in the output market. In reality, however, this does not seem to be consistent with many cases. Firms are often concentrated around the output markets. In fact, some models predict that firms may move toward the output market if their production is disproportionally productive and/or if transaction and inventory costs are high. In addition, it can be shown that firms can also move away from their monopsonized input market.

Agrobusinesses play an important role to facilitate agricultural growth in many developing countries. For rural farmers to purchase advanced inputs, such as fertilizer and improved seeds, and access the output market to sell harvested crops, transportation services must of necessity be provided by agribusinesses or trucking companies. Still, few agrobusinesses are available in many rural areas in Africa. The paper recast light on the question of why agribusinesses are not located in local production areas despite clear benefits from close proximity to their inputs.

Using the firm registry data and detailed road network data in Madagascar, the paper estimated the impacts of market and farm accessibility on agglomeration of new agrobusinesses. It is found that market accessibility is important to attract agrobusinesses. Agglomeration economies are also among the important determinants of their location. Thus, the currently existing agrobusiness clusters would likely continue to grow further. By contrast, accessibility to ports and farms does not seem to be so important for agrobusinesses to decide their locations. One of the reasons for agrobusinesses concentrating on large markets may be the better quality of labor that is available. Our findings support this. In addition, many local agrobusinesses may still retain monopsony power in their input markets. As the location model predicts, this allows them to keep relatively away from their local areas. As transport infrastructure is improved, the local agrobusiness industry would become more competitive, bringing more agrobusinesses to locate in local areas.

References

Agarwal, Deepak, Alan Gelfand, and Steven Citron-Pousty. 2002. Zero-inflated models with application to spatial count data. *Environmental and Ecological Statistics*, Vol. 9(4), pp. 341-355.

Anselin, Luc. 1988. *Spatial Econometrics: Methods and Models*. Boston: Kluwer Academic Publishers.

Caplin, Andrew, and John Leahy. 2010. Economic theory and the world of practice: A celebration of the (S, s) model. *Journal of Economic Perspectives*, Vol. 24(1), pp. 183-202.

Deichmann, Uwe, Kai Kaiser, Somik Lall, and Zmarak Shalizi. 2005. Agglomeration, transport, and regional development in Indonesia. Policy Research Working Paper No. 3477. Washington DC: The World Bank.

Elbadawi, Mengistae and Zeufack. 2006. Market access, supplier access, and Africa's manufactured exports: An analysis of the role of geography and institutions. World Bank Policy Research Working Paper No. 3942.

Fujita, Masahisa, Paul Krugman, and Anthony Venables. 1999. *The Spatial Economy*. MIT Press.

Graham, Daniel, Patricia Melo, Piyapong Jiwattanakulpaisarn, and Robert Noland. 2010. Testing for causality between productivity and agglomeration economies, *Journal of Regional Science*, Vol. 50(5), pp. 935-951.

Iimi, Atsushi, Martin Humphreys, and Sevara Melibaeva. 2015. Firms' Locational Choice and Infrastructure Development in Rwanda. Policy Research Working Paper No. 7279. The World Bank.

Khalili, Amir, Vijay Mathur, and Diran Bodenhorn. 1974. Location and the theory of production: A generalization. *Journal of Economic Theory*, Vol. 9(4), 467-475.

Krugman, Paul. 1991. Increasing returns and economic geography. *Journal of Political Economy*, Vol. 99(3), 483-499.

Lall and Mengistae. 2005. The impact of business environment and economic geography on plant-level productivity: An analysis of Indian industry. World Bank Policy Research Working Paper No. 3664.

Lee, Ki-Dong, Seok-Joon Hwang, and Min-hwan Lee. 2012. Agglomeration economies and location choice of Korean manufactures within the United States. *Applied Economics*, Vol. 44, pp. 189-200.

Lee, Youngjo, Md. Moudud Alam, Maengseok Hoh, Lars Ronnegard, and Anna Skarin. 2016. Spatial modeling of data with excessive zeros applied to reindeer pellet-group counts. *Ecology and Evolution*, Vol. 19(6), pp. 7047-7056.

Mare, David, and Daniel Graham. 2013. Agglomeration elasticities and firm heterogeneity. *Journal of Urban Economics*, Vol. 75, pp. 44-56.

McCann, Philip. 1993. The logistics-cost location-production problem. *Journal of Regional Science*, Vol. 33(4), pp. 503-516.

McCann, Philip. 1998. *The Economics of Industrial Location*. Springer, Berlin.

Moses, Leon. 1958. Location and the theory of production. *Quarterly Journal of Economics*, Vol. 72, pp. 259-272.

Mosser, Patricia. 1991. Trade inventories and (S,s). *Quarterly Journal of* Economics, Vol. 106(4), pp. 1267-1286.

Procher, Vivien. 2011. Agglomeration effects and the location of FDI: Evidence from French first-time movers. *Annals of Regional Science*, Vol. 46, pp. 295-312.

Rashid, Shahidur, Nigussie Tefera, Nicholas Minot, Gezahengn Ayele. 2013. Fertilizer in Ethiopia. IFPRI Discussion Paper No. 01304, International Food Policy Research Institute.

Sakashita, Noboru. 1967. Production function, demand function and location theory of the firm. *Papers of the Regional Science Association*, Vol. 20, pp. 109-122.

Shehata, Emad Abd Elmessih, and Sahra Khaleel A. Mickaiel, 2013. SPTOBITSAC: Stata module to Estimate Tobit MLE Spatial Autocorrelation Cross Sections Regression, Statistical Software Components S457723, Boston College Department of Economics, revised 19 Nov 2013.

Shieh, Yeung-Nan, and Chao-Cheng Mai. 1989. Demand, location, and the theory of production. *The Annals of Regional Science*, Vol. 23(2), pp. 93-102.

Teravaninthorn, Supee, and Gael Raballand. 2009. *Transport Prices and Costs in Africa*. The World Bank.

Tobler Waldo. 1970. A computer movie simulating urban growth in the Detroit region. *Economic Geography*, Vol. 46(2), pp. 234-240.

You, L. and S. Wood. 2006. An entropy approach to spatial disaggregation of agricultural production. Agricultural Systems, Vol. 90(1-3), pp. 329-347.

You, L., S. Wood, U. Wood-Sichra. 2009. Generating plausible crop distribution and performance maps for Sub-Saharan Africa using a spatially disaggregated data fusion and optimization approach. Agricultural System, Vol. 99(2-3), pp. 126-140.

World Bank. 2013. *Growing Africa: Unlocking the Potential of Agribusiness*. The World Bank.

World Bank. 2016. *Shifting Fortunes and Ending Poverty in Madagascar: Recent Findings*. World Bank Group.