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Consumer search and firm location

Theory and evidence from the garment sector in Uganda

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Consumer Search and Firm Location: Theory and Evidence from the Garment Sector in Uganda

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Abstract

This paper studies the role of consumer information frictions in driving firms' location choices within cities. I develop a quantitative equilibrium model in which imperfectly informed consumers prefer searching in high-density locations to minimize the cost of gathering information. When choosing location, firms trade-off consumers' preferences for agglomeration, fiercer competition induced by spatial proximity, and lower production costs from supply-side externalities. I estimate the model using bespoke data that I collected from garment firms in Kampala. I combine transaction data (to estimate demand), customer data (to shed light on search) and mystery shoppers data (to measures quality). I find that information frictions lead to substantial agglomeration and limit the ability of high-quality firms to attract customers, allowing lower-quality competitors to survive. Counterfactual scenarios show that the introduction of an e-commerce platform induces a large share of firms to disperse, while also causing customers to shift to high-quality businesses. By contrast, commonly adopted decongestion policies that discourage central clusters without solving information frictions disproportionately harm high-quality firms by increasing consumers' costs of finding high-quality products.

Key words: Firm location, consumer search, information frictions, low-income cities
JEL codes: R30, R32, D12, O12

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1 Introduction

In cities, economic activity tends to be spatially concentrated, with firms specializing in the production of similar goods clustering together. Quantitative models of the internal structure of cities have focused on the role of production externalities in influencing firm location and agglomeration preferences.[1] However, in low-income countries, firms typically integrate production and sale within a single location, with face-to-face interactions accounting for the majority of transactions (Startz, 2021; Bandiera et al., 2022; Bassi et al., 2022a). For these firms, access to customers is a crucial driver of economic performance.

How do customers search for products, and what are the consequences of their search behavior for the spatial distribution of firms within cities? With a projected 75% growth in the urban population in low-income countries over the next 30 years (UN, 2018), answering these questions is essential to accurately assess the welfare effects of urban policies that can shape the future of cities. Additionally, studying consumers' search behavior can provide valuable insights into the demand-side constraints that hinder high-productivity, high-quality firms from attracting customer, contributing to large resource misallocation and overall low productivity in low-income countries (Hsieh and Klenow, 2009; Bloom et al., 2010).

In this paper, I study the role of consumer information frictions for the location choices and performance of garment firms in Kampala, Uganda. When consumers have limited information about the variety of goods available in the market, they are compelled to visit firms in person to learn about product characteristics and availability. This is especially relevant in low-income settings where both customers and firms have limited access to information technology. The high cost associated with in-person visits leads consumers to favor spatially concentrated firms that allow minimizing the cost of gathering information. On the one hand, this preference for agglomeration generates demand-side externalities, incentivizing firms to locate near their competitors.[2] On the other hand, agglomeration also intensifies firm congestion and spatial competition. The trade-off between agglomeration to attract customers vs. business-stealing congestion can have first order effects on the spatial distribution of economic activity and the competitiveness of markets, with implications for the welfare consequences of urban policies.

To study this trade-off, I collect data from garment firms and their customers in Kampala.

[1] Ahlfeldt et al. (2015); Allen et al. (2015); Monte et al. (2018); Dingel and Tintelnot (2020); Owens III et al. (2020)

[2] Examples of theoretical models that incorporate demand externalities arising from agglomeration include Stahl (1982), Wolinsky (1983), Dudey (1990), Fischer and Harrington Jr (1996), Bester (1998), Arentze et al. (2005) and Konishi (2005).

I begin by documenting novel facts about consumers' search behavior and firms' choice of location in a low-income setting. Building upon these insights, I develop an equilibrium model of consumer search and firm location that incorporates information frictions, standard production externalities, and economies of scale in transport as key sources of agglomeration. Finally, I estimate the model to quantify the importance of information frictions for firm agglomeration and to evaluate the impact of various urban policies on firm location, profits and consumer welfare.

Three key findings emerge from the analysis. First, demand externalities resulting from information frictions contribute to a substantial share of the observed firm agglomeration within cities. Second, by preventing consumers from comparing all products in the market, information frictions limit the ability of high-quality firms to attract customers and favor the survival of lower-quality competitors. Third, urban policies that discourage agglomeration without addressing information frictions disproportionately harm high-quality firms. This is because the higher spatial dispersion induced by these policies increases consumers' search costs, hampering their ability to find the best products in the market.

The data from this study comes from a new survey of 600 garment firms and their customers in Kampala. Firms were randomly sampled from an initial census of over 2,400 establishments across the city. The data collection process consisted of three main components: (i) a firm survey, (ii) a customer survey, and (iii) a mystery shoppers exercise. During the firm survey, business owners were required to maintain a record of all their firm's transactions over a three-day period. These records are rarely available for small, informal businesses in low-income countries, but are essential for estimating demand. Subsequently, 600 customers were randomly sampled from the transaction records and invited to participate in a survey designed to gain insights on how consumers search for products in this context. Finally, the study included a mystery shoppers exercise, where interviewers posed as customers and purchased the same garment from all firms in the sample. This exercise provided accurate information on the price charged by firms for the same product, as well as on the quality of the product, which was rated by an expert in the garment sector.

The empirical analysis uncovers four key patterns in the search behavior of consumers and the location choice of garment firms. First, customers face approximately three times higher transportation costs when traveling to the central, denser part of the city, the *core*, compared to the costs of traveling to the *periphery*. This is due to firms concentrating in the core, while the majority of customers reside in residential areas outside the city center. However, once in the core, customers visit 22% more firms prior to purchasing, indicating lower within-location search costs in high-density areas. Second, customers purchasing products in the core buy larger quantities and pay lower unit transport costs on average compared to those in the periphery. This suggests that transport costs are fixed, making sourcing from further locations more feasible for customers buying in bulk. Third, despite having fewer customers, firms in the core serve a higher share of retailers purchasing products in bulk. As a result, they generate double the daily revenues of firms in the periphery. Fourth, firms in the core sell higher quality products.

I build a model that accounts for these patterns by incorporating information frictions, transport costs, and heterogeneous consumers (small vs. bulk buyers) in a discrete choice model of demand. Prior to searching, consumers do not observe their preferences over varieties. For instance, they may have a general idea of what type of item they want to purchase (a skirt, a dress, a shirt etc.), but may be unsure about their specific preferences regarding color, material or style until they visit the firms and observe the products in person. To do so, they incur a transport cost that depends on the distance between the customer and the firm, but is independent of the quantity purchased. Once in a location, the marginal cost of visiting an additional store decreases in firm density. As high-density locations are typically farther away from residential areas, consumers face a trade-off: they weigh the larger transport costs associated with traveling *to* denser locations against the lower search costs *within* those areas. This trade-off is less severe for bulk buyers who benefit from economies of scale in transport costs. As a result, this type of buyers are more likely to purchase products from spatially concentrated firms.

Firms sell horizontally differentiated products and are heterogeneous in terms of quality, owner's commuting distance and preferences over locations. They choose location simultaneously in a static game of incomplete information. Once in a location, firms decide on the optimal combination of land, internal labor, and outsourced labor to employ in production, and compete in a Nash-Bertrand pricing game. The presence of an additional business in the same location affects a firm's variable profits and hence influences its location choice in three ways: (i) it attracts a larger number of customers to the location (the *market-size* effect); (ii) it intensifies price competition within the location (the *market-share* effect); (iii) it attracts suppliers of external labor, thereby reducing the marginal cost of labor (the *supply-side* externality). Importantly, the trade-off between market-size and market-share effects differs for high and low-quality firms. This is because as the size of the agglomeration increases, high-quality businesses capture a larger share of the additional customers drawn to the location. Consequently, they benefit disproportionately from locating in areas with a high concentration of firms.

To estimate the model, I utilize the newly collected data from Ugandan firms and their customers. First, I combine firm transaction records with price and quality data from the mystery shoppers exercise to estimate demand. A key feature of the data is that, for each transaction, I have information on the customer's origin location, as well as on whether the buyer is a final consumer or a retailer. This allows separately identifying elasticities with respect to distance and firm density. Second, I incorporate the estimated demand into the firm's production function and use survey data on wages, rents, land and labor to identify the supply-side parameters. Finally, I combine data on the residence of firm owners with estimates of firms' expected variable profits across locations to recover the elasticity of profits with respect to commuting distance. This last step requires structurally estimating a static, simultaneous move game of location and pricing with a large number of firms and locations.

I use the estimated parameters to consider how equilibrium outcomes would change in the absence of information frictions. I find that eliminating information frictions would induce 8.2% of firms to relocate outside the core. As the majority of relocating firms are high-quality, this would cause a 42% drop in the share of sales concentrated in the core. The elimination of information frictions, allowing customers to observe and compare all products in the market, would enhance firm competition, resulting in a 14% decrease in prices and an 18% decrease profits. However, these averages mask substantial heterogeneity between high and low-quality firms. High-quality businesses would gain considerable market share and experience a 17% increase in profits. Conversely, at the new equilibrium, 37% of low-quality businesses would incur losses and be better off exiting the market. Overall, eliminating information frictions would lead to an 11% increase in consumer welfare, driven by lower prices and access to a wider range of product varieties.

I employ the model to assess two sets of counterfactual policies: (i) the introduction of an e-commerce platform, and (ii) urban policies aimed at decongesting the city center of Kampala. In the e-commerce counterfactual, I assume that customers can observe all product varieties before purchase and pay a flat fee to get products delivered to their location. This second aspect eliminates the geographical element of consumer search. Compared to the baseline scenario, the e-commerce platform leads to a 39% reduction in the number of firms operating in the core, primarily due to high-quality businesses relocating to the periphery. By eliminating information frictions, the policy harms low-quality firms, with their profits declining by over half, while it leads to a 27% increase in profits for high-quality businesses.

Policies that solely relocate firms without addressing information frictions can have unintended consequences. I examine the effects of two measures: imposing a cap to the number of firms operating in the core, and banning motorcycle-taxis from the central area of the city. In the case of caps, firm profits unambiguously decline as the restrictions are imposed.[3] High-quality firms suffer the largest losses, as the higher spatial dispersion of firms makes it more costly for consumers to compare products across different locations. Final consumers, who do not benefit from economies of scale in transport, experience gains as firms relocate closer to residential areas. By contrast, caps have a negative impact on the welfare of customers buying products in bulk, as the variety of products they can observe within the same location declines. In the experiment banning motorcycle-taxis from the city center, the policy reduces the profits of firms in the core, but increases those of businesses in the periphery. Although these effects lead 10% of firms to relocate outside the core, the impact on consumer welfare is negligible.

Agglomeration economies resulting from sharing of suppliers, labor market pooling and knowledge spillovers have been extensively studied as drivers of firm co-location in space (Duranton and Puga, 2004; Rosenthal and Strange, 2004; Ellison et al., 2010; Combes and Gobillon, 2015). Building upon the seminal work of Fujita and Ogawa (1982), production externalities have been incorporated into spatial equilibrium models that have highlighted their role as key determinants of the internal structure of cities (Lucas and Rossi-Hansberg, 2002; Ahlfeldt et al., 2015; Allen et al., 2015; Monte et al., 2018; Dingel and Tintelnot, 2020; Owens III et al., 2020). In all these models, the demand structure implies that an increase in the number of firms in a location either has no effect or it intensifies price competition among agglomerated firms. While allowing for traditional supply-side externalities, this paper contributes to this literature by introducing demand externalities that can mitigate competition among spatially concentrated firms. Quantifying this channel is crucial to accurately measure the welfare effects of agglomeration.[4]

To model demand-side externalities, this paper builds upon the industrial organization literature on consumer search with limited information about product characteristics (Hortaçsu and Syverson, 2004; Hong and Shum, 2006; Goeree, 2008; De los Santos et al., 2012). In particular, two recent studies by Murry and Zhou (2020) and Moraga-González et al. (2022)

[3]This result is consistent with findings from Bassi et al. (2022a), which show that, in the Ugandan context, (i) firms benefit from locating near larger roads, as it improves customer visibility; (ii) a policy that randomly disperses firms in space would lead to a substantial reduction in firm profits. Even taking into consideration workers' life expectancy gains from lower pollution, the authors show that the policy would have an overall negative surplus.

[4]Demand externalities in the model arise from consumers visiting firms in person to uncover information about products. This feature of the model relates to recent evidence from the urban literature showing that travel to consume is common within cities and has important implications for the spatial dispersion of economic activity (Agarwal et al., 2017; Davis et al., 2019; Miyauchi et al., 2021).

show that when consumers must travel to acquire information about products, spatial clustering can lower price elasticity and increase the market power of co-located businesses. This paper takes this literature to a very different context and contributes to it by endogenizing firms' choice of location. By doing so, it incorporates an explicit model of consumer demand with spatial differentiation, price competition, and demand and supply-side externalities in a model of firm entry and location (Bresnahan and Reiss, 1991; Mazzeo, 2002; Seim, 2006; Jia, 2008; Ciliberto and Tamer, 2009; Zhu and Singh, 2009; Vitorino, 2012; Datta and Sudhir, 2013). While entry models typically do not differentiate between demand and cost parameters and estimate the overall effect of firm entry on profits, the richness of the model and the data in this study allows making this distinction. This is crucial for isolating the effect of information frictions on firm location.

Lastly, this paper contributes to a growing literature examining the impact of information frictions on domestic and international trade flows (Arkolakis, 2010; Allen, 2014; Steinwender, 2018; Startz, 2021). Such frictions can lead to substantial inefficiencies in the formation of buyer-seller relationships, perpetuating the survival of low productivity businesses (Atkin et al., 2017; Jensen and Miller, 2018) and generating excess price dispersion in the market (Jensen, 2007; Aker, 2010; Goyal, 2010). I contribute to this literature by using demand-driven agglomeration to infer the magnitude of consumers' information frictions within a city. I then estimate the impact of these frictions on prices and the profitability of firms that are heterogeneous in terms of quality.

The paper is structured as follows. Section 2 introduces the setting of the study and the data. In Section 3, I document key facts about firms' choice of location and consumers' search behavior. I rely on this empirical evidence to motivate the structure of the model, which is presented in Section 4. Section 5 describes the estimation procedure and discusses the identification of the model parameters. Section 6 summarizes the results of the estimation, which are used to construct counterfactual scenarios in Section 7. Section 8 concludes, summarizing the key findings from the paper and outlining potential avenues for future research.

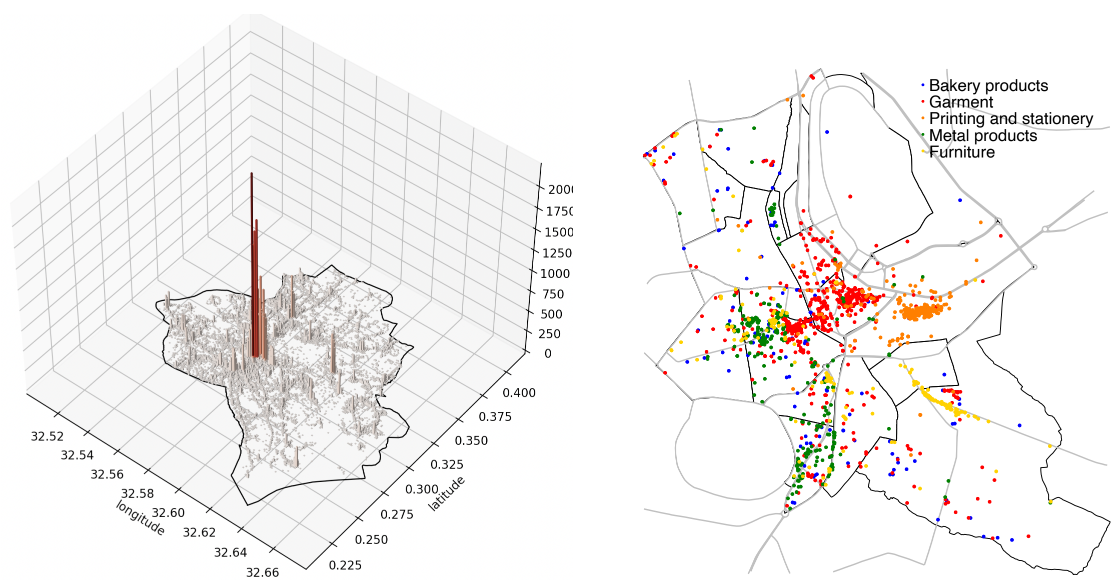
2 Setting and Data

2.1 Kampala garment sector

The setting of this study is the garment sector in Kampala. Kampala is the administrative capital and economic hub of Uganda, hosting 29% of all business establishments and contributing to 60% of the country GDP (KCCA, 2019). Panel A of Figure 1 plots the location of all formal and informal firms operating in the city. In Kampala, economic activity is heavily concentrated on a small area at the heart of city, with 40% of all establishments operating within 2 km from the central business district.[5] Within the central area, firms are clustered by sector. Panel B of Figure 1 shows the location of all the establishments operating in the central area for the top 5 Ugandan manufacturing sectors.[6] In the figure, each dot is a firm, and each color a four digit ISIC sector. The color pattern clearly shows that firms spatially sort according to their sector, with different areas of the city center hosting different industries.

Figure 1: Spatial distribution of firms in Kampala

PANEL A: All firms **PANEL B: Top 5 manufacturing sectors**



Notes: Data is from 2010 Ugandan Census of business establishments, which covers the universe of formal and informal firms in Uganda. Panel A shows he distribution of all firms within the city of Kampala, with the height of the bar indicating the number of firms located within a specific area. Panel B zooms in on the central part of the city and shows the location of all firms in the five manufacturing sectors with the highest number of establishments in Uganda. On the map, each dot is a firm and each color a four digit ISIC sector.

The focus of this study is the garment sector. Garment is one of Uganda key manufacturing industries: it accounts for 42% of all Ugandan manufacturing firms (43% of the manufacturing firms in Kampala), and employs 15% of the manufacturing labor force. Despite its size, the sector is highly fragmented: 77% of businesses consist of a single, self-employed

[5]For comparison, respectively 25% and 11% of firms in London and Los Angeles operate within 2 km of the central business district (author's calculations using CDRC 2021, County Business Patterns 2019).

[6]The top 5 manufacturing sectors are defined in terms of number of firms. The same sectors are also those employing the largest number of employees.

individual, and 84% have an annual turnover below $2,000.[7] The choice of sector for the study was driven by two elements. First, the garment sector exhibits strong spatial clustering (Panel B of Figure 1), constituting an ideal setting for studying agglomeration forces. Second, garment firms produce goods that are differentiated both horizontally and vertically. Horizontally, because firms produce different styles of garments (see Figure A1 for some examples). Vertically, because tailors possess different levels of skills and use inputs of various quality. Information frictions are more likely to emerge when consumers must acquire information on a number of product characteristics, making the garment sector a good setting to study demand-side externalities that arise from consumer search.

2.2 Data

Firm sampling The data for this study comes from an original survey of 600 garment firms and their customers. Firms were selected from an initial listing of all garment businesses operating in one of 14 randomly selected parishes in Kampala.[8] Parish selection was stratified by firm density, measured as the average number of firms per square-km operating in the parish in the latest Census of Business Establishments conducted by the Uganda Bureau of Statistics in 2010. Specifically, parish selection proceeded as follows. First, parishes with less than ten tailoring firms were dropped from the sample. Second, the remaining parishes were assigned to four strata: (i) 0-49, (ii) 50-99, (iii) 100-300, (iv) more than 300 firms per square-km. Finally, 4 parishes were randomly selected from stratum (i), 5 from stratum (ii), 3 from stratum (iii) and 2 from stratum (iv) to be part of the study. The aim of the stratification was to include the areas with the highest concentration of firms, and to have some variation in density across parishes outside of the central part of the city. Figure A2 shows the location of the selected parishes next to a map of the density of garment firms across all Kampala. Although the study only covered 14 out of the 96 parishes in the city, in 2010 68% of all garment firms in Kampala were operating in one of the sampled parish.

Interviewers conducted a door-to-door, in-person listing of all the garment firms in the selected parishes, enumerating a total of 2,407 firms.[9] Figure 2 plots the number of firms per parish using data from the listing. In line with previous census data, three parishes at the center of town host a number of firms that is substantially larger than any other parish in

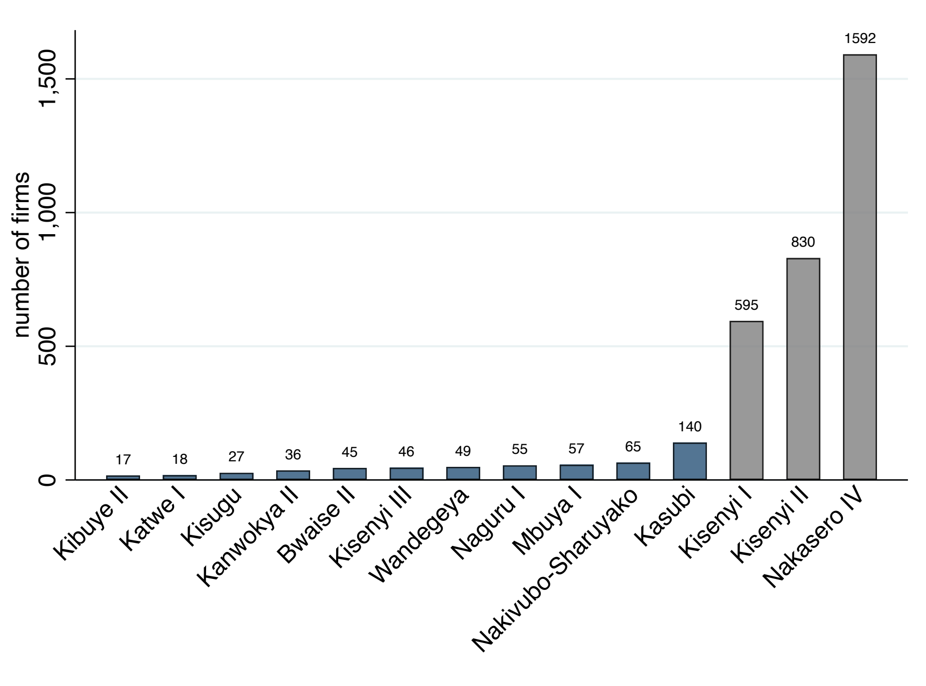
[7]These characteristics are by no mean specific to the garment sector. Excluding garment, the median manufacturing firm in Uganda has no employees and has an annual turnover below $2,000.

[8]In Uganda, the parish is the second lowest administrative unit. Kampala has a total of 96 parishes, with an average parish size of 2.03 square-km.

[9]In the two denser parishes, Nakasero IV and Kisenyi II, interviewers only enumerated one every two parish they encountered in their random walk. All estimates are weighted to account for this sampling strategy.

the sample. For the rest of the paper, I refer to these parishes as the *core* of the city, and call the remaining parishes the *periphery*. From the initial listing, approximately 300 firms in the core and 300 firms in the periphery were selected to participate in the survey. Compliance was high at 89% and not statistically different across core and periphery, resulting in a final sample of 601 firms. All results in the paper are weighted to reflect the sampling strategy.

Figure 2: Number of firms in selected parishes



Notes: Data is from the census of garment firms. Figure 2 shows the number of garment firms in each of the selected parishes. Parishes in the periphery are in blue, while parishes in the core are in gray.

Customer sampling The list of potential customers was compiled using two data sources. First, interviewers had to list all the customers that purchased products from firms during the interview. Second, firms were asked to record their transactions for the three days immediately after the survey. For each transaction, firms recorded the name and contact details of the customer, as well as information on whether the customer buying a product was a *final* consumer - an individual making a purchase for herself or her household, or a *retailer* - an individual making a purchase for her firm. Overall, the details of a 1,510 customers (64% final and 36% retailers) were collected from 385 firms.[10] From this list, 581 customers were randomly selected to take part in the survey. The selection was stratified

[10]36% of firms, equally distributed across core and periphery, did not provide information about any of their customers. Whether a customer was listed or not is uncorrelated with firm revenues and number of employees at baseline, but is positively correlated with the average weekly number of customers.

by firm location (core vs. periphery) and type of customer (final vs. business) to ensure a sufficient coverage of both customer types across the two locations.

Survey design The data collection was designed with two key objectives in mind: (i) understanding what drives the demand for a firm's products and (ii) shedding light on the determinants of firms' choice of location. Three data sources contributed to the first objective: transaction data, a customer survey, and a mystery shopper exercise. The firm survey focused on the second objective.

Transaction data provided information on the outcome of the search process. It was collected by asking owners to keep a written record of all the firms' transactions for the three days after the survey.[11] A total of 2,848 transactions were recorded, with information on the type (e.g. a dress, t-shirt, trousers, skirt), the quantity and the price at which the product was sold, the type of customer making the purchase - a final consumer or a retailer - and the location where the customer travelled from.

The customer survey was designed to complement transaction records by providing a comprehensive picture of how customers search for products. To this end, the survey included detailed questions on how consumers decide where to look for a firm and which business to buy products from once in a location.

The mystery shoppers exercise consisted in commissioning the same garment to all firms in the sample, with the aim of collecting accurate information on prices and product quality. Firms were commissioned a dress, the most common garment in this setting, designed by an expert tailor to have characteristics that would allow testing for tailors' skills. Interviewers posed as customers, and were trained to follow a script to commission the dress (Appendix A.4). Firms were provided with fabric,[12] an accurate description and, upon request, a photo of the product. The quality of the product was then rated by an expert tailor according to detailed evaluation criteria (Figure A10).

The firm survey focused on the second objective of the data collection: understanding the drivers of firms' choice of location. On top of standard firm-level information such as number of employees, revenues, profits and firm owner's characteristics, the survey included a set of questions on the firm's location history and the reasons that motivated the owner's initial location and subsequent relocation choices. Detailed data was also collected on the firm's

[11]Firm owners were provided a monetary incentive to keep transaction records. 88% of firms provided records of their transaction. Attrition was uncorrelated with firm location, number of employees, monthly revenues, firm age, and total number of weekly customers.

[12]In this setting, it is very common for customers to provide fabric to firms. Of the customers that took part in the survey, 77% reported providing firm with the material in their last purchase.

production process with the objective of investigating the potential sources of supply-side externalities.

3 Firm Location and Consumer Search in Kampala

In this section, I use the collected data to provide evidence on firms' choice of location and consumers' search behavior in Kampala. The section is divided in two parts. The first part presents summary statistics on the drivers of firms' location decision and consumers' choice of where to search for products. The second part presents five facts about the relationship between firm density, consumer search and firm production process which are consistent with the presence of quantitatively important demand and supply-side externalities in this setting.

3.1 Comparing Firms in Core and Periphery

Firms in core vs. periphery Table 1 shows summary statistics on firms, separately for businesses operating in the core and the periphery. In line with the general overview of the Ugandan garment sector, firms in the sample are small: the average business has no employees, owns three machines/tools - typically, a sewing machine, a pair of scissors and a flat iron - and operates on a 3 square-meter surface. Despite their small size, these are not businesses that have just entered the market and we should expect to see growing over time. On average, firms have been in the market for 8 years and have monthly revenues of $167, almost three times the Ugandan monthly GDP per-capita ($60). Given their size, these businesses can be considered a hybrid between a manufacturer and a retailer. Typically, production and sale are carried out by the same person in the same location, making demand-related considerations particularly important for the choice of location.

Firms in the core and in the periphery differ on a number of dimensions. The average monthly revenues of firms in the core are 78% higher than the revenues of firms in the periphery. Despite this, firms in the core employ less inputs: they have 36% less workers, use 18% fewer machines and operate on premises that are half the size of those of businesses in the periphery. There are two clear forces deterring businesses from locating in the core: commuting costs and rents. Both these costs are approximately double for firms in the core relative to firms in the periphery.

Table 1: Summary statistics

	All	**Core**	**Periphery**	**P-value**
Number of workers	1.319	1.250	1.701	{.000}
	[1.000]			
Number of machines	3.674	3.573	4.224	{.002}
	[3.000]			
Size of premises (m^2)	3.005	2.652	4.952	{.000}
	[2.000]			
Years of operation	8.001	7.974	8.151	{.814}
	[5.000]			
Monthly revenues (USD)	167.039	179.402	100.611	{.000}
	[100.442]			
Rent per square-meter (USD)	19.459	20.847	11.717	{.000}
	[14.147]			
Monthly commuting cost (USD)	36.642	39.817	19.564	{.000}
	[40.743]			
Number of observations	601	302	299	

Note: Data is from the baseline survey of garment firms. Table 1 reports means, medians in square brackets, and p-values from a t-test of equality of means in core and periphery in curly brackets. All estimates are weighted to be representative of the universe of garment firms in the sampled parishes.

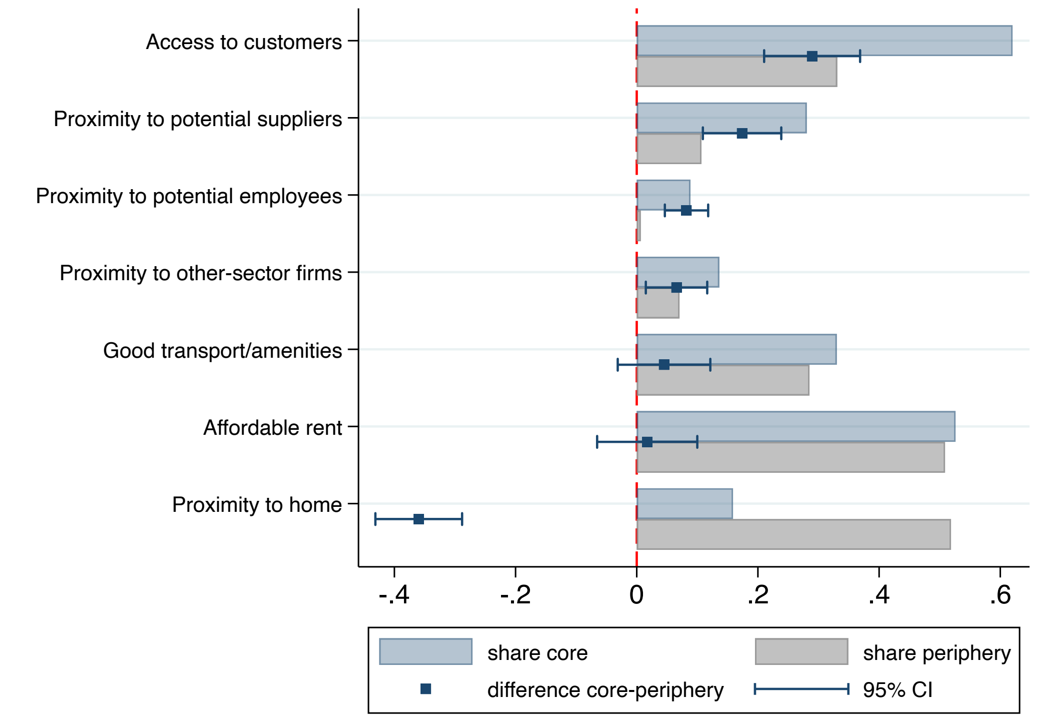
Firm mobility A key question for understanding location decisions is how mobile firms are over time. The data suggests that firms' location choice is very persistent. Table A1 shows that 54% of firms in the sample have never moved from their initial location. 23% moved into different premises, but remained within the core, or within the periphery. Only 5% and 3% of firms report relocating from the periphery to the core and vice versa.[13]

Drivers of initial location decision How do firms make their initial location decision? To answer this question, I asked firms: (i) what were the main constraints the owner faced when setting up the business, and (ii) what were the reasons that affected the firm's initial choice of location. The answers to both questions point towards demand being a key driver of firms' location choice. Finding customers is by far the most common set-up constraint, with 73% of firms mentioning it. In comparison, access to finance, which has been widely studied

[13]The remaining 14% of firms relocated from outside Kampala. Of these, 6% moved into the core, and 8% into the periphery.

as a potential barrier to starting a business in a developing country, was only reported by 53% of firms. The third most common constraint are transport costs, mentioned by 11.4% of businesses, suggesting that commuting distance to work also plays a role in owners' decision of where to locate the firm.[14]

Figure 3: Reasons for *Locating* in Core vs. Periphery



Notes: Data is from the baseline survey of garment firms. The blue bars in Figure 2 show the share of firms in the core reporting the reason indicated on the left as a driver of their initial choice of location. The gray bars show the same statistic, but for firms operating in the periphery. The blue rectangles show the difference between the share of firms in the core and the share of firms in the periphery reporting a given reason, with the bar indicating the 95% confidence interval.

Figure 3 shows the answers to the second question. Specifically, it shows: in light blue, the share of firms in the core mentioning the corresponding reason as a driver of their initial location decision; in gray, the same share, but for firms located in the periphery. The blue rectangles represent the difference between the share of firms in the core and in the periphery mentioning a given reason, with the corresponding 95% confidence interval. Two things emerge clearly from this graph. First, the primary reason why firms locate in the core is to have access to customers. Almost 60% of businesses in the core say that their location decision has been driven by the large number of customers shopping in this area. Second,

[14]Other set-up constraints are, in order of importance, high taxes/license fees (10%), finding suppliers (9.9%), lack of managerial ability (8.1%), high competition (7.1%), lack of space (6.1%), accessing machines (4.9%) and high cost of premises (4.8%).

standard agglomeration economies - such as proximity to input and machine suppliers and access to potential employees - also play a role in firms' decision to operate in the core, but they appear to be second order. Access to good transportation infrastructures and amenities (electricity and water) and affordable rent appear to be equally important for businesses in the core and in the periphery. Although this may seem surprising given that rental prices in the core are much higher than in the periphery, firms in the central location are able to rent much smaller premises (typically, a space within a room with other garment firms) and, as a consequence, total rental costs are similar across firms operating in the two types of location. Only few firms across both locations (14% and 7%) mention proximity to other-sector firms as a driver of their choice. This suggests that customers' possibility to chain trips and purchase goods from businesses in different sector (Miyauchi et al., 2021) does not play a primary role in firms' choice of locating in the core. The only reason motivating firms to remain in the periphery is proximity to home (52% vs. 16%), indicating that commuting cost are a key congestion force.[15]

3.2 Consumer Search in Kampala

The aim of the customer survey was to collect information on how consumers search for products. To this end, customers were asked detailed questions about their purchasing history. For each firm with whom the customer interacted in the last 1 to 3 months,[16] data was collected on the way in which the customer initially found the firm, the reason why she searched a particular area, the travel cost to the firm, and the number of firms visited while searching. To limit recall bias, similar questions were asked about a hypothetical scenario in which the customer had to search for a new firm.

The majority of search is through walk-ins Table 2 shows the methods employed by customers to find a new firm. Walk-ins are the most common search method, with 54% and 56% of final and retail customers respectively mentioning it. This is followed by asking family members or friends for recommendations, with 43% of customers saying they would use this method to find a new supplier. Interestingly, the number of firms visited by customers who receive a recommendation prior to purchasing is not statistically different

[15] An additional incentive for firms to operate near one another could be their ability to collude on prices. Two pieces of evidence suggest that this is not one of the main drivers of firm agglomeration in this context. First, only 7.5% of firms (8% and 4.6% in the core and periphery respectively) report benefiting from operating in proximity to other garment firms due to formal price agreements. Second, prices from the mystery shoppers exercise are, if anything, more dispersed in the core than in the periphery (Figure A3), which is inconsistent with collusion being more likely to occur in high-density areas.

[16] Business customers were asked about their purchasing history over the last month, while final customers were asked about the last 3 months.

from the number of firms visited by individuals who search randomly. This suggests that, although recommendations are common, customers still engage in independent search before buying a product. Consistent with previous findings from the literature (Cai and Szeidl, 2018), business customers are more likely to rely on other firms to find a new supplier. Only a few customers (8% and 4% among final and business) mention they would search on internet, suggesting that accessing accurate information about businesses is particularly difficult in this context.

Table 2: Way in which customers search

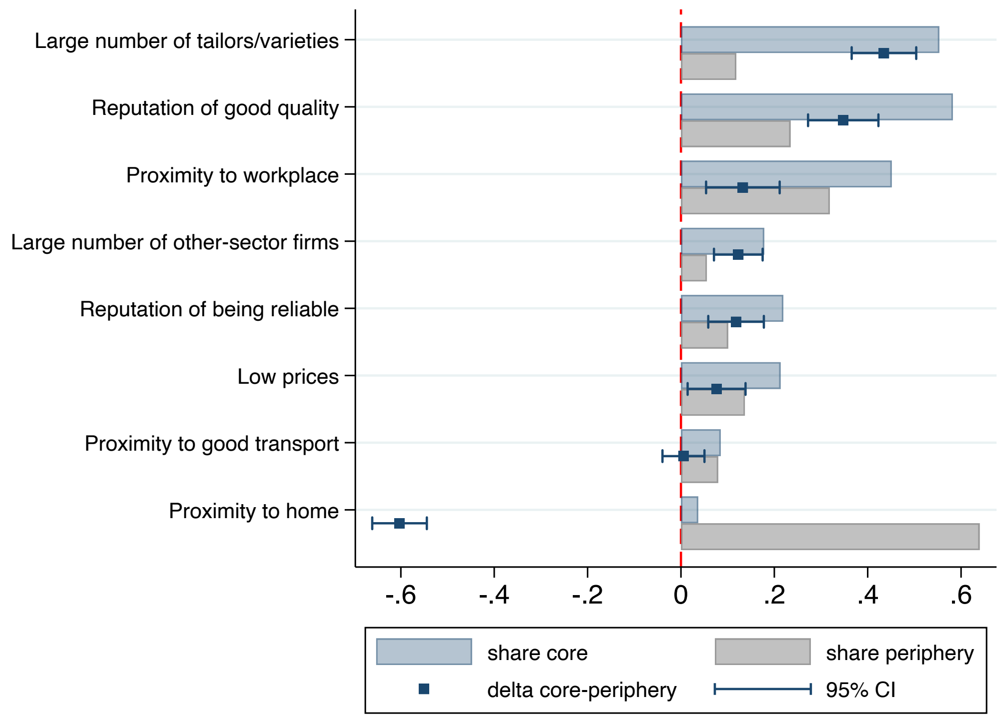
	% of final customers	% of retail customers
Walk into any firm	53.5	55.8
Ask friends/family members	43.9	42.4
Ask other garment firm	14.5	33.8
Ask firm in different sector	6.9	11.9
Look on the internet	7.9	4.0

Note: Data is from the baseline survey of customers. Table 2 reports the percentage of final and retail customers who reported they would be using the method indicated in the first column in the hypothetical scenario in which they had to search for a new firm.

Reasons for searching core vs. periphery Respondents were asked in which part of Kampala they would look for a new garment firm and why. Figure 4 shows the reported reasons, separately for customers who said they would search for a firm in the core and the periphery. The structure of the figure is analogous to Figure 3. Large number of tailors and varieties (55% of customers), firms' reputation of being good quality (58%) and proximity to workplace (45%) are the main reasons why customers search for products in the core. In relative terms, the first two reasons play a bigger role in explaining why customers prefer the core to the periphery. Trip chaining, namely the tendency to make purchases from different firms in either the same of a different sector in one trip, does not seem to play a big role in this context. Only 18% of customers in the core mention the presence of other-sector firms as a reason for searching in this location. In addition, 90% of customers report only typically buying from one garment firm when visiting a location. Low prices, which one might think could lead customers to search in high-density areas if they expect fiercer competition or ability to bargain for better prices, also play a secondary role in customers' choice of where to search.[17] Similarly to firms, the overwhelming majority of customers who search in the periphery do so to remain close to home and save in transport costs (64%).

[17]In the mystery shoppers exercise, after asking for an initial price, interviewers are instructed to ask firms for a 20% discount (see Appendix A.4). I collect data on both the initial price and the price after the discount request. On average, interviewers obtain a 12% discount on the initial price. However, I do not find

Figure 4: Reasons for *Searching* in Core vs. Periphery



Notes: Data is from the survey of customers. In Figure 3 the blue bars show, among customers who indicated they would prefer to search for a new firm in the core, the share reporting the reason on the left as a driver of their choice of location. The gray bars show the same statistic, but for customers who indicated they would prefer to search for a firm in the periphery. The blue rectangles show the difference between the share of customers searching the core and the share of customers searching the periphery reporting a given reason, with the bar indicating the 95% confidence interval.

3.3 Stylized facts about demand and supply externalities

This section presents five facts about the relationship between firm density, consumer search and firm production process, which are suggestive of the presence of quantitatively important demand and supply-side externalities. I rely on these facts to guide the structure of the quantitative model.

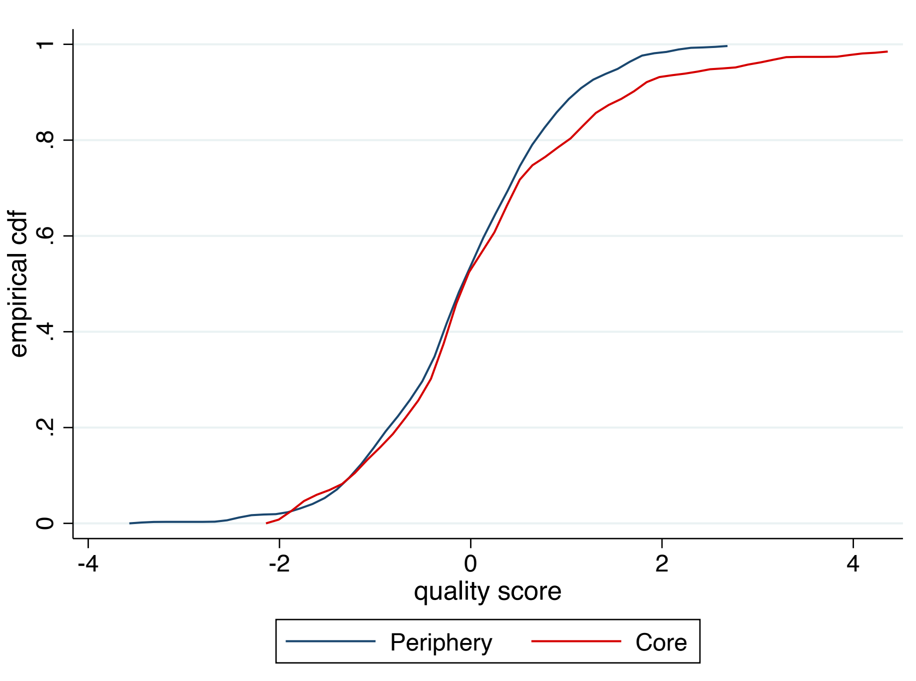
FACT 1: Customers incur large transport costs to travel to the core. Once in the core, they visit more firms prior to purchasing

93% of all transactions in this setting occur in person, with the average transport cost corresponding to 9% of the transaction value. Transport costs to a firm in the core are almost three times as high as the costs of travelling to the periphery (\$1.25 vs. \$0.48). This

a significant difference in the discount given by firms in the core and the periphery (both in absolute value and as a percentage of the initial price). This suggests that customers are not able to bargain for better prices in the core.

is without considering the opportunity cost of time: on average, the length of a one way trip to the core and the periphery is 34 and 17 minutes respectively. The reason why transport costs to the core are so high is that, while garment firms are concentrated in this area, the majority of the population lives outside the city center (Figure A4). In addition, when buying in the periphery, customers typically buy from firms that are nearby.[18] However, once in the core, customers visit 22% more firms prior to buying a product relative to customers who search in the periphery. This is consistent with (i) consumers possessing imperfect information about products and having to search prior to purchasing; (ii) search costs being lower within locations that have a higher concentration of firms.

Figure 5: Product quality distribution



Note: The figure shows the kernel density estimate of the distribution of quality scores from the mystery shoppers exercise separately for firms in the core and the periphery.

FACT 2: Firms in the core sell higher quality products

Figure 5 plots the cumulative distribution functions of the quality scores from the mystery shoppers exercise, separately for firms in the core and the periphery. It shows that, on average, the quality of goods sold in the core is 0.185 standard deviation higher than in the periphery (p-value = 0.039 - see Column 1 of Table A2).[19] There are two possible

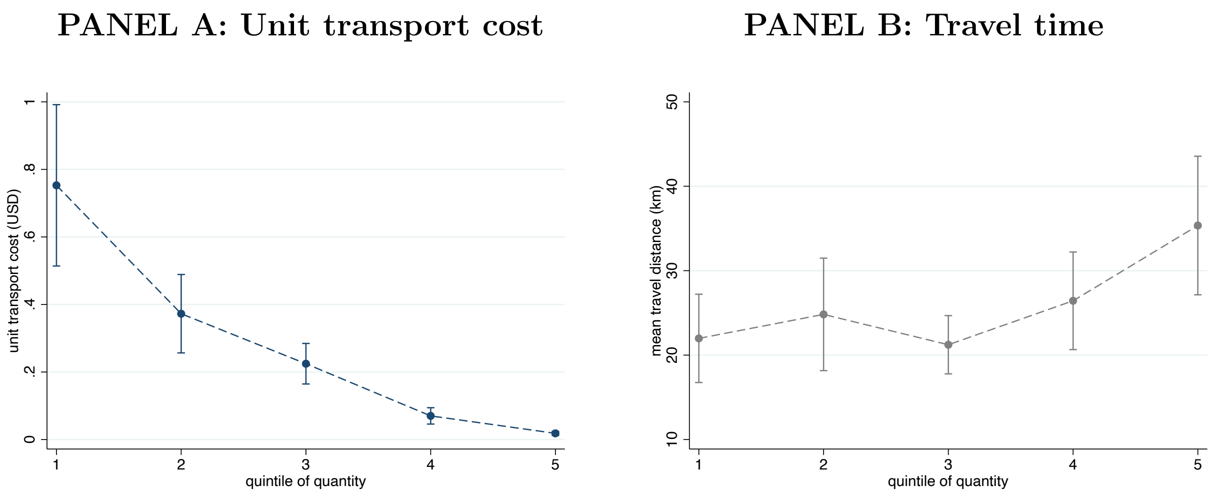
[18]Similarly, the majority of retailers that buy from firms in the core come from other parishes in Kampala (49.7%) or outside Kampala (49.2%). Only 1% of the retailers buying from firms in the core are also located in the core.

[19]This evidence is consistent with customers expecting higher quality products in the core (Figure 4).

explanations for firms in the core selling higher quality products: better firms select into the core or, within this denser area, learning is more likely to occur.

Two pieces of evidence suggest that selection is more likely to be at play in this setting. First, the difference in quality across locations is entirely driven by the tales of the distribution: the lowest quality firms in the economy remain in the periphery, while businesses that produce the highest-quality goods are more likely to operate in the core. If firms in the core were more likely to exchange knowledge and learn from one another, we should expect the entire distribution in the core to be shifted to the right (Combes et al., 2012). Second, Column 2 of Table A2 shows that (i) there is little correlation between the quality score and firm owner's experience in the garment sector, and (ii) the experience gradient is not significantly difference across core and periphery. These facts are inconsistent with learning being more likely to occur in the core relative to the periphery, suggesting that the difference in the quality distributions is driven by the best firms *selecting* into the core.

Figure 6: Unit transport cost and travel time, by quantity quintile



Notes: Data is from the survey of customers. Panel A plots the average unit transport costs (total transport costs divided by the quantity of goods purchased in a given transaction) and the corresponding 95% confidence intervals for each quintile of the distribution of purchases quantities. Panel B shows average travel distance in kilometers and correpsonding confidence intervals by quintile of the distribution of the purchased quantities.

FACT 3: Consumers buying large quantities of goods travel further and pay lower unit transport costs

Figure 6 uses data from the customer survey to plot mean travel cost and travel distance by quintile of quantity purchased. Panel A shows that there is a negative relationship between quantity purchased and unit transport cost to the location where the transaction takes place. For the lowest quintile, average transport costs to the firm correspond to 32%

of the transaction value. For the highest quintile, they only correspond to 5.5% of the transaction value. This pattern is observed despite the fact that customers buying larger quantities travel further to source their products (Panel B), suggesting that transport costs are fixed and generate economies of scale in transport.[20] The idea is simple: customers only find travelling to further locations convenient if the higher transport cost is traded-off with equally higher benefits (lower price, better styles, etc.). Final customers, who typically buy fewer units, may find it optimal to pay a higher price or acquire a less preferred product variety in the periphery and save the cost of a trip to the core. The opposite is true for retailers, who buy products in bulk and thus benefit from lower unit transport costs.

Table 3: Transaction characteristics, by location type

	(1) Daily revenues (USD)	(2) Number of daily customers	(3) Share of retail customers	(4) Transaction Value (USD)	(5) Quantity	(6) Unit price (USD)
Panel A: No Controls						
Core	9.336***	-0.163**	0.446***	8.497***	12.23***	1.848***
	(2.340)	(0.0799)	(0.0294)	(0.932)	(1.125)	(0.326)
Panel B: Product FEs						
Core				4.277***	14.80***	-0.079
				(0.860)	(1.422)	(0.243)
Panel C: Quality						
Core				4.289***	14.35***	-0.215
				(0.923)	(1.493)	(0.243)
Quality score				1.489***	-1.936**	0.836***
				(0.571)	(0.781)	(0.183)
Mean | Periphery	7.423	0.980	0.102	6.763	3.628	3.136
N. Observations	546	546	512	2,726	2,726	2,726

Note: * $p < .10$, ** $p < .05$, *** $p < .01$. Data is from transactions records and the mystery shoppers exercise (for quality scores). In Columns 1 to 3, the unit of observation is the firm. In Columns 4 to 6, it is the transaction. Panel A of Table 3 shows the results from a regression of the outcomes on a dummy equal to one for firms in the core, without any additional control. Panel B adds products type fixed effects, and Panel C additionally controls for quality scores. In Column 6, all regressions control for quantity purchased in the transaction. The mean value of the outcome in the periphery is indicated at the foot of the table.

FACT 4: Firms in the core serve fewer, but larger customers, who grant them larger revenues

Table 3 reports the results from regressions of several transaction characteristics on a dummy for whether the firm operates in the core. Columns 1 and 2 show that firms in the core have

[20] This finding is not unique to this setting. For instance, Grant and Startz (2021) find evidence of economies of scale in transport in Nigerian wholesale and retail sector.

more than double the daily revenues of businesses in the periphery, despite serving 18% fewer customers. The larger revenues of firms in the core are driven by the fact that they serve a higher share of retailers (Column 3: 55% vs. 10% in the periphery). The key difference between these two types of customers is in terms of the number of units that they purchase in a typical transaction (Column 5). For instance, the median customer in the periphery - a final consumer - buys one unit of product, while the median customer in the core - a retailer - purchases five units of the same product (mean: 3.6 and 16 units). As a result, for the same type of product, the average transaction size is 65% larger in the core relative to the periphery (Column 4, Panel B).

The difference in purchased quantities is not explained by customers buying different types of products or by differences in quality across locations. In fact, the coefficient on the core dummy in Column 5 barely changes with the inclusion of product type fixed effect (Panel B) and the product quality score obtained from the mystery shoppers exercise (Panel C). Interestingly, I also find that there is no significant difference in the prices charged by firms in the core and the periphery after controlling for product fixed effects, quality score and number of units purchased (Column 6, Panel C).[21]

FACT 5: Firms in the Core are more likely to outsource intermediate tasks

Data from the firm survey shows that outsourcing is very common in the Ugandan garment sector, with 40% of the production being carried out by external workers.[22] The most commonly outsourced tasks are overlocking (50% of firms), making buttonholes (20%) and ironing (13%). This type of firm-to-firm interactions are comparable to the machines rental market studied by Bassi et al. (2022b) in Ugandan carpentry sector, which provide firms with a workaround for the market imperfections that prevent investments in machines and allow firms to mechanize. Similar constraints are likely to apply to the garment sector.[23]

Panel A of Table 4 shows summary statistics on outsourcing separately for firms located in

[21] I also do not find a significant difference in average prices from the mystery shoppers exercise across the two locations (p-value = 0.347). These findings are consistent with customers *not* mentioning prices as a key determinant of the decision of where to search for goods (Figure 4).

[22] The firm survey included detailed question about the production process of a specific garment. Firm owners were asked: (i) how many workers were involved in the production of a typical garment and, (ii) of those, how many were employed by the firm and how many are hired externally to perform a specific task. The share of outsourced production is calculated as the ratio of external to total workers.

[23] Machines rental is not very common in the garment sector. The data shows that only 8% of businesses in the periphery and 10% in the core rent any machine. A possible explanation for the different behavior is that while carpentry is characterized by decreasing returns, the garment sector is likely to have increasing returns from specialization, which makes outsourcing a better strategy for organizing production.

the core and the periphery. On average, firms in the core: (i) employ more workers in the production; (ii) are 14 percentage points (24%) more likely to employ at least one external worker; (iii) outsource a larger share of their production to external workers (42% vs. 32% in the periphery). The fact that outsourcing is more common in the core could explain why these firms employ less workers, own fewer assets and operate on smaller premises than firms in the periphery (Table 1).

Table 4: Outsourcing

	Core	Periphery	P-value
PANEL A: Outsourcing			
Total number of workers	2.240	1.927	[0.000]
Any external worker	0.726	0.583	[0.000]
Share of external workers	0.418	0.324	[0.000]
PANEL B: Distance from Suppliers			
Within 5 minutes	0.954	0.557	[0.000]
Between 5 and 15 minutes	0.040	0.188	[0.000]
More than 15 minutes	0.005	0.257	[0.000]

Note: Data is from the baseline survey of garment firms. Table 4 shows means and p-values from a t-test of equality of means across core and periphery, controlling for product type fixed effects. Panel A shows the total number of workers employed in the production of the most typical product sold by the firm, the share of firms that employ at least one external worker, and the total share of external workers employed in production. Panel B shows the average walking distance to the majority of external workers employed by the firm.

Differences in outsourcing across core and periphery arise because suppliers of intermediate tasks are also geographically concentrated in the core. For instance, more than 95% of task providers in the core are located within a 5 minutes walking distance from the firm, compared to only 56% in the periphery (Table 4, Panel B). Proximity to suppliers reduces both transport costs and information frictions. It reduces transport costs by limiting the opportunity cost of bringing and picking up products from suppliers. At the same time, it lowers the cost of monitoring suppliers, which can be substantial in contexts with weak contractual enforcement. This evidence suggests that the ability of firms to outsource tasks at a lower cost is an important source of production externalities in this context.[24]

[24] There is no evidence that firms in the core are more likely to be operating at capacity. When asked by how much firms could increase their production without hiring more workers or buying more machines, 62% of businesses in both the core and the periphery say they could double it or more. Only 7% of firms in the core and 12% of firms in the periphery report they could not increase their production. This evidence also suggests that firms' ability to share big orders with nearby firms is not among the main drivers of firm agglomeration.

4 Model

In this section, I present a model of consumer search and firm location in the presence of information frictions. The key mechanisms in the model are guided by the evidence presented in Section 3. In short, uninformed consumers prefer to search for goods in locations with a high spatial concentration of firms, where they can observe a larger variety of products at a lower search cost. Since denser locations are further away from residential areas, this force is particularly strong for consumers buying in bulk, who benefit from economies of scale in transport. Combined, access to information and economies of scale in transport generate demand-side externalities. On the production side, firms that operate within denser locations can outsource production to external suppliers at a lower cost. This reduces firms' marginal costs, generating a standard supply-side externality. The congestion forces that push firms towards the periphery are fiercer within-location price competition, higher transport costs and factor prices in high-density locations.

I build the quantitative framework in three steps. First, I develop a discrete choice model of demand that embeds imperfect information and economies of scale in transport. I show how these two mechanisms can lead to demand for a firm's products being higher in locations with a larger number of competitors. Second, I model firms' price and inputs choices explicitly, allowing businesses to hire external labor to carry out parts of the production. Finally, I study how agglomeration and congestion forces affect firms' location decision, which I model as a static game of incomplete information.

4.1 Setup

The economy consists of a finite set of locations $l = \{1, 2, ..., N\}$ and features a discrete number of firms[25] and consumers: J and I. *Firms* are single-product,[26] produce differentiated goods and have idiosyncratic preferences over locations. They decide: (i) where to locate; (ii) what price to charge; (iii) what combination of land, internal labour and outsourced labor to employ. *Consumers* only purchase one type of good,[27] but are heterogeneous in the quantity demanded of a given good q. They are exogenously distributed across locations and have idiosyncratic preferences over products and idiosyncratic search costs across locations.

[25] The baseline model does not feature firms' entry in the market. For estimation, this is equivalent to explicitly modelling entry, with an entry cost that is calibrated to make the number of entrants predicted by the model equal to the number of firms in the data, as in Seim (2006). However, the key difference is that in this setting the number of firms is kept fixed in the counterfactuals. In Appendix A.6 I present an extension to the model where I allow for firm entry.

[26] Transaction data shows that on average 75% of a firm's transactions involve the sale of one product.

[27] Transaction data shows that 92% of customers only purchase one type of good in a given transaction.

They choose: (i) in which location to search; (ii) within the chosen location, what product to buy. All interactions between firms and consumers occur in person.

The model is static. This assumption is justified by evidence in the data that suggests that firms' and consumers' choices are persistent,[28] and by the need of making the computation of a spatial equilibrium with many locations and firms tractable. The theoretical framework should therefore be seen as modelling the formation of firm-customer matches and firm location decisions that persist over time.

4.2 Demand

Utility The utility of consumer i buying q units of product j in location l is given by:

$$u^q_{ijl} = \Big(\beta \mathbf{x}_j + \xi_j + (1-\sigma)\varepsilon_{ij}\Big) q^\theta - \alpha p_{jl} q - C_{il} \tag{1}$$

$\mathbf{x}_j$ and ξ_j reflect product j's observable and unobservable quality, over which all consumers have the same ranking (*vertical differentiation*). ε_{ij} is an idiosyncratic match value, which consumers only observe upon visiting a firm. It reflects the preferences of consumer i for the the style (color, cut, fit, etc.) of a garment produced by firm j, which enters utility according to consumers' specific tastes (*horizontal differentiation*). I assume that ε is distributed as a standard type-I extreme value, with $\sigma \in [0, 1]$ governing the variability of the taste shocks within a location. p_{jl} and q are respectively the price and the quantity demanded of a given good. The quantity demanded is heterogeneous across consumers and treated as an exogenous consumer type.

Search cost To visit location l, consumers must pay a search cost C_{il}. Crucially, the search cost does not depend the quantity purchased, which embeds the idea of this type of costs being fixed. I specify the search cost as:

$$C_{il} = \tau_1 g(||z_i - z_l||) + \tau_2 \frac{N_l}{ar_l} + \omega_{il} \tag{2}$$

$\tau_1 g(||z_i - z_l||)$ represents the transport cost to the firm, which is a function of the distance between the consumer location and the firm location. $\frac{N_l}{ar_l}$ is the number of firms per

[28]In Section 3, I discussed firm mobility and showed evidence of the firm's location decision being persistent. Among consumers, the average length of firm-customer relationships is 2 years and 10 months. In addition, the most common reason customers report for terminating previous relationship is firm closure or relocation. This suggests that, once they find a good match, consumers keep buying products from the same supplier. In Appendix A.5.3 I test this assumption by adding a second period to the model.

square-kilometer within the location, with ar_l representing the area of the location in square-kilometers. This term allows for consumers to face an additional firm-specific search cost once in a location. ω_{il} is an individual-location specific idiosyncratic search cost, which captures for example random information that consumers may receive from other individuals about a specific location. I assume ω is distributed according to a standard type-I extreme value distribution.

Timing The timing of the consumer choice is the following:

1. Before searching, consumers observe all product and location characteristics $(\mathbf{x}_j, \xi_j, p_{jl}, C_{il})$, but do not observe the match-specific values ε_{ij}. Given this information, they choose which location to visit.
2. Upon paying the search cost, consumers observe the match value ε_{ij} of all firms operating in the selected location and buy the product that yields the highest utility.

Prior to searching, consumers have the outside option of not buying any of the products sold in the sampled locations. However, once in a location, consumers do not have an outside option and must buy one of the products. I normalize the utility of the outside option u_0 to be zero for final customers, but allow retail customers to have a different outside option, which I estimate.

Location choice. Consumers search the location that maximizes their expected utility V_{il}^q. Given the assumption on the distribution of ε, the expected utility from a given location l takes the following form:

$$V_{il}^q = E_\varepsilon \left[\max_{j \in l} u_{ijl}^q \right] = q^\theta (1-\sigma) \ln \left(\sum_{j=1}^{N_l} \exp \left(\frac{\delta_{jl}^q}{1-\sigma} \right) \right) - C_{il} + \frac{\gamma}{1-\sigma} \tag{3}$$

where $\delta_{jl}^q = \beta \mathbf{x}_j - \alpha p_{jl} q^{1-\theta} + \xi_j$ denotes the mean utility from product j for consumers of type q, N_l is the number of firms operating in location l and γ is the Euler constant.

There are two things worth noticing about this expression. First, all else equal, the expected utility from a given location is increasing in the number of firms operating in that location (N_l). This can be seen from the summation in equation (3.4.3) being increasing in N_l at a given set of prices. Intuitively, the reason why consumers prefer larger locations is that they observe more draws of the idiosyncratic match value ε (or more varieties of the same product). In expectation, this implies that they have a higher probability of finding a product that exactly matches their tastes.[29] This is the source of the demand-side externality in the model. The positive effect of agglomeration on demand is however mitigated by search costs being higher in locations that have a larger number of firms ($\frac{N_l}{ar_l}$).

Second, the agglomeration force is stronger: (i) the larger the quantity q bought by the consumer; (ii) the higher the dispersion of firm-specific taste shocks within a location (lower σ). Agglomeration is stronger for consumers buying in bulk because the extra utility that they obtain from finding a better match is gained over all the units of products that they buy. A lower σ implies a lower similarity among the products sold in the same location. From the point of view of the customer, this increases the marginal value of having an additional product sold in the location.

Let $\mathbf{L} = \{l_1, l_2, ..., l_J\}$ denote the $J \times 1$ vector of firm locations and let $\mathbf{p} = \{p_{1l_1}, p_{2l_2}, ..., p_{Jl_J}\}$ denote the $J \times 1$ vector of prices, with l_j and p_{jl_j} respectively indicating the location and the price charged by firm j in the chosen location. For simplicity, from now on I omit the subscript j when referring the firm location l_j. The share of type-q customers from location i buying products in location l is given by the following expression:

$$s^q_{il}(\mathbf{L},\mathbf{p}) = Pr(V^q_{il} \geq V^q_{il'} \,\forall\, l' \neq l)$$

$$= \frac{\left(\sum_{j=1}^{N_l} \exp(\frac{\delta^q_{jl}}{1-\sigma})\right)^{q^\theta(1-\sigma)} \exp(-\tau_1 g(||z_i - z_l||) - \tau_2 \frac{N_l}{ar_l})}{\exp(u^q_0) + \sum_{k=1}^{N} \left[\left(\sum_{h=1}^{N_h} \exp(\frac{\delta^q_{hk}}{1-\sigma})\right)^{q^\theta(1-\sigma)} \exp(-\tau_1 g(||z_i - z_k||) - \tau_2 \frac{N_k}{ar_k})\right]} \tag{4}$$

This expression reveals the forces affecting firm competition *across* locations. First, the summation at the numerator reflects the demand-side externality: by offering a large number of varieties, locations with a higher number of firms N_l attract a higher share of customers. I call this effect the *market-size* effect. In line with the earlier discussion, this force is stronger for customers buying in bulk (high q), and the lower the substitutability of products sold within a location (low σ). However, firm-specific search costs ($\tau_2 \frac{N_k}{ar_k}$) reduce the relative attractiveness of large locations by increasing the cost of acquiring information in locations that have a high number of firms. Second, the share of customers visiting location l is increasing in the quality of products sold in the location ($\mathbf{x}_j$ and ξ_j), and decreasing in prices (p_{jl}) and in the travel distance to the location ($||z_i - z_l||$).

[29]This is a well known property of variants of logit discrete choice models (see Anderson et al. (1992)).

Conditional firm choice. Conditional on searching location l, the share of type-q consumers buying products from firm j is:

$$s^q_{j|l}(\mathbf{p}_l) = Pr(u^q_{ijl} \geq u^q_{ij'l}\,\forall\, j' \neq j\ in\ l) = \frac{\exp(\frac{\delta^q_{jl}}{1-\sigma})}{\sum_{h=1}^{N_l}\exp(\frac{\delta^q_{hl}}{1-\sigma})} \tag{5}$$

This second expression reflects firm competition *within* a location. Notice that, all else equal, the share of customers purchasing products from firm j is decreasing in the number of firms operating in the location N_l. This is intuitive: keeping the pool of customers that visit location l fixed, the presence of an additional firm means that customers have an additional alternative they can choose. I refer to this effect as the *market-share* effect. Firms with a higher mean utility δ_{jl}, namely firms offering higher quality products and charging lower prices, attract a higher share of customers and are less affected by within-location competition.

Unconditional firm choice. Equations (3.4.4) and (3.4.5) show that, at a given set of prices, the presence of an additional firm has two effects on the demand for a firm products: (i) it attracts customers to the location by increasing the number of available varieties (*market-size effect*); (ii) it increases search costs and intensifies competition within a location (*market-share effect*). These two effects are reflected in the unconditional demand for firm j's products, which is the product of equations (3.4.4) and (3.4.5):

$$s^q_{ijl}(\mathbf{L},\mathbf{p}) = s^q_{il}(\mathbf{L},\mathbf{p}) \times s^q_{j|l}(\mathbf{p}_l) =$$
$$= \frac{\exp(\frac{\delta^q_{jl}}{1-\sigma})\left(\sum_{j'=1}^{N_l}\exp(\frac{\delta^q_{j'l}}{1-\sigma})\right)^{q^\theta(1-\sigma)-1}\exp(-\tau_1 g(||z_i - z_l||) - \tau_2\frac{N_l}{ar_l})}{\exp(u^q_0) + \sum_{k=1}^{N}\left[\left(\sum_{h=1}^{N_h}\exp(\frac{\delta^q_{hk}}{1-\sigma})\right)^{q^\theta(1-\sigma)}\exp(-\tau_1 g(||z_i - z_k||) - \tau_2\frac{N_l}{ar_l})\right]} \tag{6}$$

The overall impact of the number of firms N_l on demand depends on the relative strength of the market-size and the market-share effects. To illustrate this, I temporarily assume that mean utility is constant across firms within the same location ($\delta^q_{jl} = \bar{\delta}^q_l$)[30] and set $\tau_2 = 0$. In Appendix A.1.1 I show that, under these assumptions, the marginal effect of an additional firm on the unconditional demand from type-q consumers is given by the following

[30] This is not without loss of generality, as it implies that prices do not vary with the number of firms. However, I defer the discussion of prices to Section 4.3.

expression:

$$\frac{\partial s^q_{ijl}}{\partial N_l} = s^q_{il} {s^q_{j|l}}^2 \Big(q^\theta (1-\sigma)(1-s^q_{il}) - 1 \Big) \tag{7}$$

Proposition: If $\delta^q_{jl} = \bar{\delta}^q_l \; \forall \; j \in l$ *and* $\forall \; l$, and if $\tau_2 = 0$, s^q_{ijl} is increasing in N_l if and only if $s^q_{il} < 1 - \frac{1}{q^\theta(1-\sigma)}$.

The proof follows simple algebra.

Notice that the marginal effect of an additional firm is more likely to be positive: (i) the higher the quantity purchased q,[31] (ii) the lower the similarity of taste-shocks σ, and (iii) the lower the share of customers purchasing products in the location s^q_{il}. I have already discussed (i) and (ii). On point (iii), equation (3.4.7) shows that, although the marginal effect $\frac{\partial s^q_{ijl}}{\partial N_l}$ is non-monotonic in s^q_{il}, it eventually becomes negative as s^q_{il} increases. Intuitively, if a location is already attractive - because it hosts a large number of firms, offers high-quality products at low prices, or because it is geographically close to consumers - then an additional firm only changes its relative attractiveness by a small margin.[32]

The last thing worth noticing about equation (3.4.7) is that $\frac{\partial s^q_{ijl}}{\partial N_l}$ is increasing in absolute value in $s^q_{j|l}$. This implies that firms with a higher mean utility δ^q_{jl} benefit the most from agglomeration if the marginal effect of an additional firm is positive, but are also harmed the most by it if it is negative. This has important implications in terms of *selection*, as it implies that if $\frac{\partial s^q_{ijl}}{\partial N_l} > 0$, a larger share of high-quality firms will select into larger locations. The opposite is true if the sign of the inequality is reversed.

Aggregating over all consumer types, the overall demand for firm j in location l is given by:

$$Q_{jl}(\mathbf{L},\mathbf{p}) = \int q s^q_{ijl}(\mathbf{L},\mathbf{p}) dF(q,z) \tag{8}$$

where $dF(\cdot)$ is the exogenous joint distribution of customer types and origin.

[31] Notice that the inequality never holds for $q = 1$, as in this case the right hand-side of the inequality becomes negative.

[32] At the limit, if all firms operate within the same location (ignoring consumers' outside option) Equation (3.4.6) reduces to Equation (3.4.5), and the agglomeration effect is null.

4.3 Supply

4.3.1 Production and outsourcing

Firms produce output using labor ℓ and land h according to the following Cobb-Douglas, constant-returns to scale production function:

$$f(h, \ell) = A_l \ell^{\delta} h^{1-\delta} \tag{9}$$

I assume that all firms are equally productive, but allow locations to have heterogeneous productivity, for example due to different amenities. Labor is a composite input produced by combining a continuum of perfectly complementary tasks t: $\ell = min\{x(t)|t \in [0,1]\}$. This is a plausible assumption for the garment sector, where the production is organized in sequential steps.[33] Tasks can be produced internally or be outsourced: $x(t) = \frac{l_I}{a(Z)} + l_E$, where l_I and l_E denote internal and external labor respectively, and Z is the share of internally produced tasks.

Producing a task externally requires one unit of labor. The external technology is provided by a continuum of perfectly competitive intermediate tasks providers[34] who sell labor at marginal cost w, where w the is market wage for both internal and external labor. Procuring an external task requires firms to pay an additional cost (e.g. for transport and/or monitoring) that depends on the number of garment firms operating in the location, $T(N_l) > 1$. The cost of one unit of external labor is therefore $wT(N_L)$. In the presence of agglomeration economies related to the sharing of suppliers, this cost will be decreasing in the number of firms in the location: $dT/dN_l < 0$.

Producing a task internally requires $a(Z)$ units of labor. I assume that, as firms internalize more tasks, their productivity decreases: $a'(Z) > 0$. Intuitively, this could be interpreted as firms moving away from their core competency (Eckel and Neary, 2010), or as a consequence of learning-by-doing. At the optimal level of outsourcing Z^*, the firm is indifferent between using internal or external labor to produce a task. This occurs at the threshold $a(Z^*) = T(N_l)$.

Proposition: If $dT/dN_l < 0$, as N_l increases, Z^* decreases and firms outsource a larger share of production to suppliers of external tasks.

[33]Typically, these steps are: designing, sampling, laying, marking, cutting, stitching, checking, finishing, pressing and packaging.

[34]Intermediate task providers are distinct from garment firms and do not enter my sample.

Because of the Leontief technology in tasks production, the input quantities must satisfy: $\frac{l_I}{a(z)} = l_E = \ell$. The marginal cost of producing tasks internally and externally is therefore the same and equal to $wT(N_l)$. Firms will choose how much labor and land to employ in production to maximize

$$\max_{h,\ell} \pi_{jl}(h,\ell) = \max_{h,\ell} p_{jl} A_l h^{1-\delta} \ell^{\delta} - rh - wT(N_l)\ell \tag{10}$$
$$\text{s.t. } Q_{jl} = A_l h^{1-\delta} \ell^{\delta}$$

where Q_{jl} is the demand for a firm's product. Given firms' optimal choice of land and labor, marginal costs are given by the following expression:

$$c_l = \frac{1}{A_l}\left(\frac{wT(N_l)}{\delta}\right)^{\delta}\left(\frac{r}{1-\delta}\right)^{1-\delta} \tag{11}$$

Notice that this expression is constant for all firms in a given location and decreasing in N_l if the cost of outsourcing $T(N_l)$ decreases with the number of firms operating in a location. This is the microfoundation of the supply-side externality that generates agglomeration economies in the model.

4.3.2 Prices

Conditional on their location choice and on the spatial distribution of other garment businesses, firms play a static Nash-Betrand pricing game by simultaneously setting the price of their product. They choose prices to maximize variable profits:

$$\pi_{jl}(\mathbf{L},\mathbf{p}) = \Big(p_{jl} - c_l\Big) Q_{jl}(\mathbf{L},\mathbf{p}) \tag{12}$$

Optimal prices are implicitly given by the expression below, where I omit the arguments $\mathbf{L}$ and $\mathbf{P}$ (see Appendix A.1.2 for a derivation):

$$p^*_{jl} = c_l + \frac{1-\sigma}{\alpha}\left(\frac{\int q s^q_{ijl} dF(q,z)}{\int q s^q_{ijl}[q^{-\theta} + s^q_{j|l}((1-\sigma)(1-s_{il}) - q^{-\theta})] dF(q,z)}\right) \tag{13}$$

In Appendix A.1.3 I show that the net effect of agglomeration on prices is ambiguous and depends on the relative strength of three forces. First, marginal costs decrease in the number of firms in a location due to cheaper outsourcing, leading to lower prices. Second, within-location competition pushes prices downwards via the market-share effect. Finally, demand-side externalities arising from the market-size effect soften competition and push prices upwards.

The system of best response equations can be written as:

$$\mathbf{p} = \mathbf{c} - \Lambda(\mathbf{p})^{-1} Q(\mathbf{p}) \tag{14}$$

where Λ is the $J \times J$ matrix of price derivatives (Berry, 1994). A Nash-Bertrand equilibrium of this game is a vector $\mathbf{p}^*$ that solves (14). In Appendix A.1.4, I follow Mizuno (2003) to derive the conditions for the existence and uniqueness of a price equilibrium. Due to the presence of externalities, when the market-size effect is strong the uniqueness of an equilibrium is not guaranteed.

4.4 Location

I model firms' choice of location as a static game of *incomplete information* in which firms owners simultaneously choose where to locate their business. Firms can only enter one location, and so the set of choice alternatives for firm j is $l_j \in \{1, 2, ..., N\}$. Owners choose location to maximize the following profit function:

$$\Pi_{jl}(\mathbf{L},\mathbf{p}) = \pi_{jl}(\mathbf{L},\mathbf{p}) - \tau_3 g(||z_j - z_l||) - e_{jl} \tag{15}$$

where $\pi_{jl}(\mathbf{L},\mathbf{p})$ are the firm's variable profits in location l as expressed in equation (3.4.12) and $\mathbf{L} = (l_j, \boldsymbol{l}_{-j})$, with $\boldsymbol{l}_{-j}$ being the vector of actions of all firms other than j. To enter a location, owners must pay a commuting cost ($\tau_3 g(||z_j - z_l||)$) which depends on the distance between the owner's residence/workplace and the firm.[35] While it is standard in the urban literature to incorporate commuting costs in the employee's choice of workplace, these do not typically enter the firm location problem. Including commuting costs in this context is important for two reasons: first, they constitute a sizeable share of the firm's costs, corresponding to approximately 22% of firms' monthly revenues. Second, 80.1% of the labor force in low-income countries is self-employed.[36] For these individuals, the choice of workplace coincides with the choice of where to locate the business.

Finally, e_{jl} is an idiosyncratic entry or set-up cost, which is firm specific and is private

[35] When I estimate the model, I consider distance from the customer's residence for final customers and distance from workplace for retailers.

[36] For comparison, the corresponding figure is 77% for Uganda and 6.1% for the United States.

information to the firm. Incomplete information guarantees the existence of an equilibrium of the entry game Doraszelski and Satterthwaite (2010) and is more realistic in a context in which information frictions are large.

Externalities Demand and supply-side externalities enter the firm's choice of location via their effect on variable profits. To illustrate this, I assume that there is an continuum of firms and take the total derivative of profits with respect to the number of firms in a location at the optimal prices $\mathbf{p}^*$:

$$\frac{d\Pi_{jl}(\mathbf{L},\mathbf{p}^*)}{dN_l} = \frac{d\pi_{jl}(\mathbf{L},\mathbf{p}^*)}{dN_l} = \underbrace{(p^*_{jl} - c_l)\frac{\partial Q_{jl}(\mathbf{L},\mathbf{p}^*)}{\partial N_l}}_{\text{demand externality}} - \underbrace{\frac{\partial c_l}{\partial N_l} Q_{jl}(\mathbf{L},\mathbf{p}^*)}_{\text{supply externality}} \tag{16}$$

The sign of $\frac{\partial Q_{jl}}{\partial N_l}$ depends on the relative magnitude of the market-size and market-share effects: if the former prevails, firms face higher demand in larger locations and have a demand-side incentive to agglomerate. The sign of $\frac{\partial c_{jl}}{\partial N_l}$ depends on the effect of N_l on outsourcing costs $T(N_l)$. Cheaper outsourcing in locations with a larger number of firms lowers marginal costs, generating a supply-side externality. Notice that, although I do not model the land market explicitly, in the data firms pay higher rental costs in geographically concentrated locations. Therefore, marginal costs may overall be higher in areas with a higher density of firms.

Bayesian Nash equilibrium Since firms have imperfect information about the profitability of other businesses, they choose location based on their expected profits: $E_{\mathbf{e}_{-j}}[\Pi_{jl}]$, where $\mathbf{e}_{-j}$ is the matrix of unobserved shocks for firms other than j. I assume that shocks e are iid across firms and locations, and are distributed according to a type-1 extreme value with scale parameter μ, which is known to all firms. By the independence of private information, a firm's expected profits from entering location l can be expressed as:

$$E_{\mathbf{e}_{-j}}[\Pi_{jl}(e_{jl})] = \int \pi_{jl}(l_j, \boldsymbol{l}_{-j}|\mathbf{e}_{-j}) \prod_{h\neq j} dG(e_h) - \tau_3 g(||z_j - z_l||) + e_{jl} \tag{17}$$

Firms' expected profits from location l can be rewritten in terms of *Conditional Choice Probabilities* (CCPs). Let $\mathbf{P}^a \equiv \{P_j(l_j|\boldsymbol{l}_{-j}) : j \in J; l_j \in N; \boldsymbol{l}_{-j} \in N^{J-1}\}$ be the vector of conditional choice probabilities associated with a given a set of strategy functions $a = \{l_j(\boldsymbol{l}_{-j}, \mathbf{e}_j) : j \in J\}$. Firms' expected profits, which I denote by $\bar{\Pi}^a_{jl}$, can be rewritten as a function of this vector:

$$\bar{\Pi}^a_{jl}(e_{jl}) = \sum_{\boldsymbol{l}_{-j}} \left(\pi_{jl}(l_j, \boldsymbol{l}_{-j}) \prod_{h \neq j} P^a_h(l_h) \right) - \tau_3 g(||z_j - z_l||) + e_{jl} \tag{18}$$

where the summation is taken over all the possible combinations of the actions of firms other than j, with the number of combinations being equal to N^{J-1}.

Definition : A *Bayesian Nash Equilibrium* (BNE) is a set of strategy functions $a^* = \{l^*_j(\boldsymbol{l}_{-j}, \mathbf{e}_j) : j \in J\}$, such that for any firm $j \in J$ and any $e_{jl} \in R^{J \times L}$, $l^*_j(\boldsymbol{l}_{-j}, \mathbf{e}_j) = \arg\max_l \{\bar{\Pi}^{a}_{jl}{}^*(e_{jl})\}$

Let $\mathbf{P}^*$ be the vector of CCPs associated with a^*. Given the assumption on the distribution of the e shocks, the Bayesian Nash equilibrium can be characterized as the fixed point of the best response mapping:

$$\Psi_j(l_j|\mathbf{P}^*) = \frac{\exp\left(\left(\sum_{\boldsymbol{l}_{-j}} \pi_{jl}(l_j, \boldsymbol{l}_{-j}, J) \prod_{h \neq j} P^*_h(l_h) - \tau_3 g(||z_j - z_l||)\right)/\mu\right)}{\sum_{k=0}^{N} \exp\left(\left(\sum_{\boldsymbol{l}_{-j}} \pi_{jk}(k_j, \boldsymbol{l}_{-j}, J) \prod_{h \neq j} P^*_h(l_h) - \tau_3 g(||z_j - z_k||)\right)/\mu\right)} \tag{19}$$

Proposition: The location game has at least one equilibrium.

Given the assumption on the distribution of private information, the best response probability functions (equation (3.4.19)) are well defined and continuous in the compact set of players' choice probabilities. Hence, by Brouwer's fixed point theorem, there exists at least one equilibrium. However, as it is common in entry games, the equilibrium might not be unique.

5 Estimation

To quantify demand and supply-side externalities, I structurally estimate the model. The estimation is carried out in three steps. First, taking firm location and production choices as given, I combine transaction data and data from the mystery shoppers exercise to estimate the demand parameters $\boldsymbol{\theta_1} = \{\alpha, \beta, \sigma, \theta, \tau_1, \tau_2\}$ via maximum likelihood. Second, given the estimated demand parameters and data on wages and rents across locations, I simulate firms' choice of land and labor. I estimate firms' production function and supply-side externality parameters $\boldsymbol{\theta_2} = \{\delta, A_l, T(N_l)\}$ using a simulated method of moments approach. Finally, I use the Rust's Nested Fixed Point algorithm (Rust, 1987) applied to a static setting to estimate the remaining commuting cost parameter $\boldsymbol{\theta_3} = \{\tau_3\}$ for the entry game.

An important aspect of the estimation is the assignment of firms to locations. In the baseline estimation, I assume that a location corresponds to a parish, but consider parishes in the core to be one location. I justify this choice in Appendix A.2.

5.1 First Step: Demand parameters

I use firm transaction data to estimate demand via weighted exogenous sampling maximum likelihood (Manski and Lerman, 1977). Taking firm location and prices as given, the log-likelihood function takes the following form:

$$\ln L(\boldsymbol{\theta_1}|\mathbf{L},\mathbf{p}) = \sum_{i,q,j,l} w_j \times I_{iqjl} \times \ln s^q_{ijl}(\mathbf{L},\mathbf{p}) \tag{20}$$

where s^q_{ijl} is the probability that a consumer of type q from location i purchases products from firm j in location l, which is expressed by equation (3.4.6). w_j are sampling weights and I_{iqjl} is an indicator for whether a consumer of a given type purchases a product from firm j. The parameters to be estimated are $\boldsymbol{\theta_1} = \{\alpha, \beta, \sigma, \theta, \tau_1, \tau_2\}$.

What is key about my dataset is that it contains information about the location where the customer travelled from, as well as the type of customer - final or retailer - making the purchase. The former provides information on the distance between customer and firm $||z_i - z_l||$. I assume that distance enters utility linearly and calculate it as the driving time between the centroids of the customer and the firm parish. One drawback of the data is that customer location is missing for around 19% of transactions. For an additional 16% the firm reported the name of the district, but not the exact parish where the customer travelled from. For these observations customer location is imputed. Appendix A.3.1 provides a detailed description of the imputation procedure.

The customer type maps directly into the quantity purchased. In line with my data, I assume that there are only two types of customers in the economy: final customers and retailers. I assume that final customers always buy one unit of the purchased good ($q_f = 1$).[37] By contrast, retailers buy ten units ($q^r = 10$), the median transaction size for this type of consumers in the data. As previously mentioned, final customers' outside option is normalized to zero ($u^f_0 = 0$), while retailers' outside option u^r_0 is estimated within the

[37] 59% of final customers in the transaction data buy one unit of good. 94% buy less than five units.

likelihood (details in Appendix A.3.2).

When estimating the model, I face a trade-off between adding heterogeneity on the firm side and keeping the estimation of the entry game computationally feasible. This is because the state space for the latter grows exponentially as the number of firm types increases. Therefore, I assume that firms only differ along one observable dimension: product quality. Specifically, I assume that firms are either *high* or *low* quality.[38] I choose this dimension for two reasons: first, quality is by far the most important characteristic customers consider when searching for products.[39] Second, mystery shoppers data show a strong correlation between prices and product quality.[40] Including quality in the demand estimation is therefore important for the unbiasedness of the price coefficient. This point is discussed in more detail in the identification subsection.

5.1.1 Identification

In this section I provide a discussion of the model identification. I start with the identification of mean utility parameters $\{\alpha, \beta\}$ and discuss in detail how I address price endogeneity. I then discuss the identification of parameters governing the agglomeration/competition trade-off $\{\sigma, \theta\}$ and of the search parameters $\{\tau_1, \tau_2\}$.

Mean utility parameters Intuitively, mean utility parameters α and β are identified from variation in within-location market shares across firms with different prices and product quality. I allow the coefficient on product quality β to differ for final and retail customers. Variation in the share of final and retail customers buying products from high and low-quality firms that operate within the same location separately identify the two coefficients.

Price endogeneity An important implication of the assumption that firms only differ in terms of quality is that there is no unobserved firm heterogeneity ($\xi_j = 0$). This can be a concern for the estimation of the price coefficient α, as it implies that, conditional on quality, there are no omitted variables that simultaneously explain variation in firm prices and demand. To mitigate this concern, I construct the log-likelihood using prices from the mystery shoppers exercise instead of transaction data. Reassuringly, mystery shoppers prices are strongly correlated with prices from transaction data. Table A3 shows that, controlling for product quality and type of product sold, a unit dollar increase in mystery shoppers

[38] To assign firm types, I use data from the mystery shoppers exercise. Specifically, I assign firms with a quality score above average to be high quality, and firms with a score below average to be low quality.

[39] 87% of customers mention product quality as an important characteristics to consider while searching for firms. This is follower by good customer care and timely delivery, mentioned by 58% and 40% of customers.

[40] A one standard deviation increase in the quality score is associated with an 8% increase in price.

prices is associated with a \$1.08 increase in transaction prices (p-value<0.001). However, the exogeneity of mystery shoppers prices is more plausible than that of transaction prices. By construction, mystery shoppers purchased identical products from all firms. Interviewers were also trained to follow a script to ensure a similar interaction with firms and were provided with clear instructions on how to bargain for prices, which is a common practice in this setting (see Appendix A.4 for details).

This is of course not sufficient to ensure that there is no residual unobserved heterogeneity that is correlated with both prices and demand. To further test this assumption, I rely on additional data collected by mystery shoppers. In Table A4, I show the results from a regression of mystery shoppers prices on the quality score and a number of variables potentially correlated with both demand and prices. Quality is strongly correlated with prices: a one standard deviation increase in the quality score is associated with a 4.7% increase in price. Additional measures of the quality of customer care and store appearances, the timely delivery of products, and firms' advertising efforts do not significantly explain prices. The only variable that has a significant effect on prices is a 0 to 10 score of the cleanliness of the business premises. As a robustness check, in Appendix A.5.1 I re-estimate demand allowing for unobserved heterogeneity and show that the estimated price coefficient does not substantially change. Overall, this evidence supports the plausibility of the exogeneity of mystery shoppers prices once quality is controlled for.

Agglomeration/competition trade-off Broadly speaking, σ governs the correlation of product taste shocks within the same location: the larger the σ, the lower the dispersion of taste shocks and the higher the competition among firms in the same location.[41] The identification σ is similar to that of the nesting coefficient in nested logit models. Importantly, this parameter is not separately identified from the variance of the search cost shock ω, which is therefore normalized to one (Ben-Akiva et al., 1985). The identification then relies on variation in the share of same type, similarly distant customers buying from firms that operate in locations of different sizes. To illustrate this, I assume without loss of generality that all firms have the same mean utility $\delta^q_{jl} = 0 \; \forall j, l$, and let the search parameters τ_1 and τ_2 be equal to zero. Under these assumptions, the share of *final* customers purchasing from firm j in location l is given by:

$$s^f_{ijl} = \frac{N_l^{-\sigma}}{1 + \sum_{k=1}^{N} \left(N_k^{1-\sigma} \right)} \tag{21}$$

[41]This is what Berry and Waldfogel (1999) refer to as the *business stealing* effect.

It is straightforward to see that σ is pinned down by variation in market shares across locations with different numbers of firms. Notice that when $\sigma = 0$ (minimum within-location competition) equation (3.5.2) reduces to $s^f_{ijl} = \frac{1}{1+\sum_{k=1}^{N} N_l}$: all firms have the same share of customers, independently of how many other firms operate within the same location. When $\sigma = 1$ (maximum within-location competition), $s^f_{ijl} = \frac{1}{N_l}$: all that matters for firm demand is the number of businesses operating in the same location.

To discuss the identification of θ, I maintain the same assumptions and look at the share of *retail* customers purchasing from firm j in location l:

$$s^r_{ijl} = \frac{N_l^{q^\theta(1-\sigma)-1}}{\exp(u_{i0})^r + \sum_{k=1}^{N} \left(N_k^{q^\theta(1-\sigma)} \right)} \tag{22}$$

Given σ, θ is identified by variation in the share of retail customers purchasing from firms that operate in locations with different N_l.

Identification of search parameters The remaining parameters to identify are those governing demand elasticity to travel distance (τ_1) and firm density within a location (τ_2). Variation in the share of same type customers who buy products from locations that have a similar inclusive value $IV_l^q = \sum_{j=1}^{N_l} \exp(\frac{\delta^q_{jl}}{1-\sigma})$, but differ in distance from customers and firm density identifies τ_1 and τ_2 respectively. Notice that the identification of the former is allowed by the availability of data on buyers' origin.

5.2 Second Step: Supply parameters

Exploiting data on rents, wages, labor and land from the firm survey, I estimate the supply-side parameters via simulated method of moments. These include the production function parameters δ and A_l, and the supply-side externality $T(N_l)$. I simulate firms' choice of labor and land given demand and the factor prices observed in the data:

$$h^*_{jl} = \frac{Q_{jl}}{A_l} \left(\frac{(1-\delta) w_l T(N_l)}{\delta r_l} \right)^{\delta} \quad \ell^*_{jl} = \frac{Q_{jl}}{A_l} \left(\frac{\delta r_l}{(1-\delta) w_l T(N_l)} \right)^{1-\delta} \tag{23}$$

Since the goods market must clear, the quantity produced by firms in equilibrium must be equal to demand. I therefore construct the demand for a firm's product using the parameters estimated in the first step, and plug it into the firm optimal choice of land and labor. I take rents and wages from the data. Although I do not explicitly model land and labor markets, I allow rents to be parish specific and wages to differ across core and periphery. Finally, I assume that the externality takes the following functional form: $T(N_l) = 1 + N_l^T$. This parametrization is akin to an iceberg transport cost and captures the idea that firms in denser areas are geographically closer to suppliers of intermediate inputs.

The targeted moments are the mean number of workers, including firm owner and external employees, the mean size of the business premises, and the mean ratio of workers to business premises in each of the locations. Given rents and wages, the variation in ratios of land to labor *across* different locations pins down the supply side externality: $\frac{\ell^*_{jl}/h^*_{jl}}{\ell^*_{hk}/h^*_{hk}} = \frac{r_l w_k T(N_k)}{r_k w_l T(N_l)}$. When T is known, the ratio of labor to land *within* locations identifies δ. Finally, given demand, the values of mean land and labor identify the productivity parameter A_l for the different locations.

5.3 Third Step: Location parameters

The estimation of the commuting parameter τ_3 follows Rust's (1987) Nested Fixed Point (NFXP) algorithm.[42] A fixed point of the NFXP is a pair $\{\boldsymbol{\theta}_3^*, \mathbf{P}^*\}$ that satisfies:

(i) $\boldsymbol{\theta}_3^* = \arg\max_{\boldsymbol{\theta}_3} \sum_j \sum_l \ln \Psi_j(l|\mathbf{P}^*, \boldsymbol{\theta}_3) I_{lj}$

(ii) $\mathbf{P}^* = \Psi(\mathbf{P}^*, \boldsymbol{\theta}_3^*)$

where I_{lj} is an indicator function for firm j being located in l and $\Psi(\mathbf{P}^*, \boldsymbol{\theta}_3)$ is given by equation (3.4.19). For this part of the estimation, I consider garment firms in the entire city of Kampala and not only those operating in sampled parishes.[43] However, I consider the location decision of owners from outside Kampala as exogenous.[44] The biggest challenge for the computation of the NPL fixed point are the memory requirements associated with the size of the state space. In the model, the computation of the best response function in (19) requires computing variable profits for $N \times J \times N^{J-1}$ possible states, where N is the number of parishes where a firm owner can choose to locate its business and J is the total number of firms. In my setting, there are 96 locations and 3,742 firms, which makes the computation very clearly unfeasible. To reduce the state space, I need to make assumptions about firms' choice sets, heterogeneity and the information firms have about other businesses.

[42]The location parameter μ is not identified, and is therefore normalized to 0.75 of a standard deviation of firms' variable profits.

[43]This is because, with the demand and supply parameters at hand, the only data required to compute firms' best responses in the entry game ($\Psi(\mathbf{P}, \boldsymbol{\theta}_3)$) are the number garment firms operating in a parish, the number of firm owners born in a parish, factor prices and productivity.

[44]1,195 out of 2,496 firms operating in the core are from outside Kampala. I do not model the entry decision of these firms and assume they stay in the core regardless of other firms' behaviour.

Choice set Firm owners' location is taken exogenously from the data. I assume owners' can only choose to locate their business in the parish where they reside or in the core, which reduces the number of locations from which a firm can choose from 96 to 2. This choice is supported by the data. First, proximity to home is by far the main reason why owners prefer the core to the periphery (Figure 3). Second, among owners operating in the periphery, 50% have their business in the same parish where they live.

Firm heterogeneity As previously mentioned, I assume that firms are either high or low quality. Reducing the number of types reduces the state space dramatically. This is because what matters for computing firms' variable profits is the number of firms of a given type operating in each parish and not their identity. However, firms also differ in the location where the owner resides. So, even with high and low quality firms only, the model would feature 192 types of firms. If firms were uniformly distributed across types, the size of the state space would be approximately $2 \times 192 \times 18^{192}$, which is of the order of magnitude of 10^{243}. Again, computation with such a large state space is unfeasible.

Information The last assumption I make for the tractability of the problem is about the information firms have about other businesses. I assume that firms know the total number of high and low-quality firms in the economy, but have no information about where other owners come from. When making their location decision, they assume that other owners are uniformly distributed across the 93 parishes outside the core and that these parishes are identical in terms of factor prices, productivity and distance from customers.[45] This reduces the size of the state space to approximately 33 million.

To obtain firm j's best response function $\Psi_j(l|\mathbf{P}, \boldsymbol{\theta_3})$, I need to compute variable profits $\pi_{jl}(l_j, \mathbf{n}_k)$ for all possible configurations k of other firms' actions. Notice this is only a function of the firm's location l_j and the number of high and low-quality firms (other than j) in core and periphery in each configuration ($\mathbf{n}_k$). This still requires computing the Nash Bertrand equilibrium of the price game in each of these configurations. Although it is feasible in terms of memory space, the computation would be very time consuming. Following Aguirregabiria and Vicentini (2016), I compute variable profits only for a subset S of the actual state space[46] and use interpolation to approximate variable profits for configurations outside this set. I

[45] I assume that this representative parish has factor prices and productivity equal to the average value across the periphery parishes in sample. Distance from customers in a given parish is computed as the average distance between the centroid of that parish and all other periphery parishes in Kampala.

[46] $S = \{\mathbf{n}_1, \mathbf{n}_2, ..., \mathbf{n}_S\}$, with $\mathbf{n}_k$ a vector containing the number of high and low-quality firms operating in the core and the periphery in a particular configuration. I randomly choose the grid points in S from a uniform distribution over $\{1, 2, ..., n_l\} \times \{1, 2, ..., n_h\}$, where n_l and n_h are respectively the total number of low and high-quality firms in the economy. The size of the subset is 10% of the size of the total state space.

use the following interpolation function:

$$\Gamma_{jl}(\mathbf{n}_k) = \begin{cases} \pi_{jl}(l_j, \mathbf{n}_k) & \text{if k} \in \text{S} \\ \gamma^T_{0l} + \gamma^T_{1l} n_{Lk} + \gamma^T_{2l} n^2_{Lk} + \gamma^T_{3l} n_{Hk} + \gamma^T_{4l} n^2_{Hk} + \gamma^T_{5l} n_{Lk} n_{Hk} + & \\ \quad + \gamma^T_{6l} n^2_{Lk} n_{Hk} + \gamma^T_{7l} n_{Lk} n^2_{Hk} & \text{if k} \notin \text{S} \end{cases} \tag{24}$$

where n_{Lk} and n_{Hk} are respectively the number of low and high-quality firms in the core in configuration k, and $T \in \{L, H\}$ is the type of firm j. The γ parameters are obtained by running an OLS regressions of variable profits on the explanatory variables for the values of $\mathbf{n}_k$ in S. The fit of the regression for the set of points in subset S is shown in Figure A5. With the variable profits at hand, I can use Rust (1987) iterative algorithm to find the NFXP fixed point. The estimation routine consists in first solving the fixed point mapping in Equation (3.4.19) at an initial guess of the parameter $\boldsymbol{\theta}_3$. Once the fixed point probabilities are obtained, they feed into the log-likelihood $\mathcal{L}(\mathbf{P}^0) = \sum_j \sum_l \ln \Psi_j(l|\mathbf{P}^0, \boldsymbol{\theta}_3) I_{lj}$, which is maximized with respect to $\boldsymbol{\theta}_3$. This procedure is repeated until both probabilities and parameters converge.

6 Model Estimates and Fit

Table 5 shows the results from the estimation separately for demand, supply and location parameters. Panel A reports estimates of the demand parameters. Estimated coefficients are of the expected sign: the price coefficient is negative, while the quality coefficient is positive and more than three times larger for retailers relative to final customers. σ and θ are key drivers of the competition vs. agglomeration effect. A necessary condition for the market-size effect to outweigh the market-share effect is that $q^\theta > \frac{1}{1-\sigma}$. The parameter estimates show that this is satisfied for retail customers ($q^\theta_r = 2.07$, $\frac{1}{1-\sigma} = 1.49$), while, by construction, it does not hold for final customers ($q^\theta_f = 1$).

Both travel and firm-specific search cost parameters τ_1 and τ_2 are negative. The magnitude of the former implies that, on average, final customers' transport costs correspond to 14.4% of the transaction value. For retail customers, the corresponding figure is 1.5%, in line with the presence of economies of scale in transport. Across all customers, average transport costs correspond to 7.5% of the transaction value, which is close to the percentage observed in the data (9%). The negative sign of τ_2 implies that customers must pay additional firm-specific search costs once in the location. This cost is economically meaningful for final customers shopping in the core: it corresponds to 4.2% of the value of transactions and to around one third of the average transport cost. For retail customers, who make larger transaction, this additional cost is negligible (less than 0.1% of the transaction value). As a result of the trade-off between product variety and transport/search costs, it is primarily retail customers who purchase products in the core.

Table 5: Estimated parameters

	Parameter	Estimate	Std Error
PANEL A: Demand			
Price (USD)	α	-0.064	(0.016)
Quality final customers	β_f	0.205	(0.083)
Quality retail customers	β_r	0.724	(0.377)
Taste shocks correlation	σ	0.329	(0.210)
Quantity multiplier	θ	0.316	(0.083)
Travel cost	τ_1	-0.139	(0.016)
Within location search cost	τ_2	-0.0004	(0.0004)
PANEL B: Supply			
Labor share	δ	0.651	(0.030)
Outsourcing cost	T	-0.521	(2.170)
Productivity Core	A_{core}	18.122	(3.035)
Productivity Periphery (mean)	A_{per}	10.045	(2.647)
PANEL C: Location			
Commuting cost	τ_3	-5.046	

Note: Table 5 shows point estimates and standard errors for the model parameters. Standard errors are bootstrapped using 100 bootstrapped samples.

To test the fit of the demand model, Panel A of Figure 7 shows the estimated and predicted share of customers by parish. The prediction traces the data quite closely, suggesting that the model captures the key determinants of demand. If anything, the estimated share of customers purchasing goods in the core is underpredicted by the model. This could be due to additional amenities that customers benefit from in the core,[47] which I am unable to separately identify using my data. Panel B of Figure 7 shows the share of customers purchasing from a given firm within a location ($s_{j|l}$ in the model). Comparing conditional shares tests more closely whether the variation induced by prices and quality is able to explain

[47] For example due to cross-sector trip chaining, as documented by Myauchi et al (2021) for Tokyo and Oh and Seo (2022) for Seoul.

the allocation of customers across firms within the same location. Overall, the estimated shares follow the trend in the data, but there is a considerable amount of noise. This is not surprising considering theere is limited firm heterogeneity in the model.

Panel B of Table 5 shows the results of the supply-side estimation and Table A5 reports the data and simulated moments for goodness of fit. The cost of outsourcing is decreasing in the number of firms operating in the same location, in line with the presence of supply-side externalities. The magnitude of the estimate implies that the cost of procuring intermediate tasks ($T(N_l)$) decreases by 20% moving from the smallest parish in the sample to the core. In addition, firms are on average more productive in the core, as shown by the relative size of the productivity parameter A_l. This could be a reflection of firms in the core having access to better infrastructures or more productive inputs. However, Table A6 shows that there is a large variation in productivity across parishes in the periphery, with A ranging from 3 to 24. This is reassuring because it means that higher productivity is not systematically related to a larger number of firms. In turn, it suggests that there are no additional supply-side externalities or selection of better firms into larger locations which can explain residual variation in firm productivity across parishes.

The last panel of Table 5 shows the estimated commuting cost parameter. The magnitude of the estimate implies that commuting costs correspond to 17% of firms' average variable profits in equilibrium. The Bayesian Nash Equilibrium associated with this estimate sees 30.5% of low-quality firms and 46% high quality firms choosing to locate in the Core. This is in line with the data, where the corresponding figures are 32.6% and 48.5%. The result indicates that high quality firms are more likely to select into the core and is consistent with consumers reporting to prefer the core due to firms' reputation of being better quality (Figure 4). Positive selection is driven by two elements in the model: first, high quality firms benefit most from demand-side externalities. This is in line with equation (3.4.7), which shows stronger effects for firms with larger within-location shares. Second, retail customers value quality the most and, regardless of quality, they are more likely to search for products in larger locations. This generates a complementarity between customer preferences and firm location, inducing high-quality firms to locate their business in the core.

Robustness I test the robustness of the estimates by (i) re-estimating demand allowing for price endogeneity and using instrumental variables for prices to identify α; and (ii) re-estimating demand and supply using an alternative definition of locations, in which the three parishes in the core are considered separate locations. Details and results are provided in Appendix A.5. I find that parameter estimates only change slightly in these alternative estimations. In addition, I test the assumption of the model being static by adding a second period to the model and allowing customers to buy from a different firm (in the same or a different location) after observing the taste shocks for products sold in the location visited in the first period. I find that even if customers were allowed to change seller, 83% would choose to go back to firm they bought products from in the first period.

7 Counterfactuals

In this section, I use the estimated model parameters to consider two sets of counterfactuals. First, I consider how equilibrium outcomes would change in the absence of information frictions, and study the effects of introducing an e-commerce platform that alleviates both information frictions and transport costs. Second, I evaluate the impact of two different policies aimed at decongesting the central area of Kampala.

7.1 Reducing search frictions

The first counterfactual studies the effect of shutting down information frictions. This exercise is not meant to simulate a real-world policy, but rather to give a sense of the importance of these types of frictions for equilibrium outcomes and welfare. Under the *no information frictions* scenario, I assume that customers can observe all product characteristics prior to purchasing, but must travel to the firm in person to complete the purchase. I then construct a second counterfactual that simulates the introduction of an e-commerce platform reducing both information frictions *and* transport costs.

No information frictions I study the impact of eliminating information frictions by setting the idiosyncratic search cost ω_l to be equal to zero. Under this scenario, customers can observe and compare product varieties across all locations prior to purchasing. However, transactions are still conducted in person: to purchase the product customers must pay a transport cost to the location, as well as a firm-specific within-location search cost.[48] In Appendix A.1.5, I derive demand and optimal prices for this scenario. I re-compute variable profits using the new demand system and find the BNE by searching for the fixed point to the system of best response functions given by equation (3.4.19). Since the model could feature multiple equilibria, I search for fixed points starting from different initial beliefs.[49] All searches lead to the same equilibrium, which suggests it is unique.

[48] With complete information, this search cost could be seen as the cost of finding the firm once in a location.

[49] These include beliefs that all firms locate either in the core or the periphery, or that one type of firm locate in the core, and the other type in the periphery.

The results from this exercise are presented in Table 7. The first column shows the share of firms in the core, average prices, profits and consumer welfare[50] in the baseline scenario with both information frictions and transport costs. The second column shows the same statistics in the counterfactual with no information frictions. Eliminating information frictions reduces the share of firms operating in the core by 8.1%. This change masks a big shift in the composition of firms across core and periphery. While in the baseline scenario the majority of firms operating in the core are of high quality (60%), when frictions are removed it is primarily low-quality firms that choose to locate in the core, with the share of high-quality businesses dropping to 42%. The reason for these heterogeneous effects is that, as discussed in Section 4.2, high-quality firms are less affected by the within-location competition and hence benefit the most from agglomeration when consumers are imperfectly informed. Due to this shift in firm composition, the removal of information frictions leads to a 42% drop in the share of sales concentrated in the core.

When information frictions are eliminated, prices and firm profits decrease by 14% and 18% on average. Lower prices, combined with access to a large number of varieties, increase consumer welfare by 11%. The impact on profits is heterogeneous across firms. High-quality businesses experience a 17.5% increase in firm profits, while the profits of low-quality firms drop by more 60%. This is because consumers are only able to compare product varieties within the same location when variety is uncovered upon visiting a firm. Once frictions are removed, consumers can compare the varieties sold by firms across all locations before visiting any location, which enhances competition and harms low-quality firms disproportionately.

In Appendix A.6, I present an extension to the model in which firms are allowed to enter and exit the market. The scope of this extension is to recover firms' entry costs and assess what share of the businesses currently operating in the economy would find it profitable to entry and exit under different counterfactual scenarios. Given the current number of firms in the market, 37% of low-quality businesses would make negative profits and benefit from exiting the market once information frictions are removed. By contrast, an additional 20% of high-quality firms would find it profitable to enter. Although computing the number of businesses that would be operating in the market at the new equilibrium is beyond the scope of this exercise, these numbers suggest that with the elimination of information frictions (i) the total number of firms in the economy would decrease, (ii) the composition of firms would shift, leading to a larger share of high-quality firms in the market.

[50] As it is standard in discrete choice models (Small and Rosen, 1981), consumer welfare is calculated as the expected maximum value of consumer's utility divided by the price coefficient: $E_{\varepsilon,\omega}(\max_j U^q_{ijl})/\alpha$

Table 7: Profits and welfare in counterfactual scenarios

	Baseline	No information frictions	E-commerce
Share of firms in core	0.365	0.335	0.222
		-8.2%	**-39%**
Share of high-quality in core	0.460	0.313	0.098
		-22%	**-79%**
Share of low-quality in core	0.305	0.349	0.300
		+14%	**-1.6%**
Share of sales in core	0.382	0.222	0.065
		-42%	**-83%**
Average price	20.44	17.52	17.38
		-14%	**-15%**
Average profits	476.0	391.0	411.3
		-18%	**-14%**
Average consumer welfare	19.22	21.31	32.80
		+11%	**+71%**

Notes: Table 7 shows firm location, prices, profits and consumer welfare in the baseline version of the model and the three counterfactual scenarios.

E-commerce platform For the second counterfactual, I assume that customers can observe all varieties on an e-commerce platform (no information frictions) and pay a flat fee to get products delivered to their location. The goal of this exercise is to simulate the creation of an online platform where firms can sell their products. I calibrate the delivery fee to the fee charged by Jumia, Ugandan main online shopping website, which is approximately 1.58$ and the same for all locations within the city. The results of this counterfactual are presented in the last column of Table 7.

The creation of an e-commerce platform for garment firms reduces the share of firms and sales concentrated in the core by 39% and 83% respectively. The magnitude of these changes shows that the geographical centrality of the core, which makes it an easy location to reach from consumers across all Kampala, is a key driver of agglomeration. The reduction in the share of businesses in the core is driven by a relocation of high-quality firms, while the distribution of low-quality firms across locations only changes slightly with respect to the baseline scenario. Average prices and profits decrease on average, with heterogeneous effects on low and high-quality firms (-64% and +27%). As a result of no information frictions and lower product transport costs, consumer welfare increases by 70%. Overall, these results indicate that the introduction of an e-commerce platform would have large positive effects, with high-quality firms gaining market share over lower-quality businesses, the share of firms in the core sharply decreasing, and consumers benefiting from a large raise in welfare.

7.2 Decongestion policies

Firm agglomeration comes at a high cost in terms of travel time and congestion. In Kampala, travel time is estimated to be 13.5% of the city GDP plus an additional 4.2% considering congestion (Baertsch, 2020). This led governments across Africa to introduce policies aimed at relocating informal businesses outside of city centers and reducing traffic congestion. I simulate the impact of two types of urban policies that are currently being discussed in Uganda. The first one is the introduction of a cap to the number of firms allowed to operate in the core, paired with the eviction of firms in excess. The second one is the creation of a congestion zone in Kampala city center, where motorcycle taxis (boda-bodas), which cover 42% of city daily trips (KCCA, 2016), are banned.

Firm caps I study the effect of limiting the percentage of firms that can operate in the core to a range between 0 and 50% of firm owners.[51] I assume that the same cap applies to both low and high-quality firms across all parishes. Figure 7 plots changes in average firm profits and consumer welfare with respect to the baseline scenario. The red vertical line at 35% indicates the point at which the cap only becomes binding for high-quality firms. At 50% the cap is no longer binding for any type of firm, so the equilibrium in the market goes back to the baseline scenario.

Panel A of Figure 7 shows that firm profits unambiguously decline as caps are imposed, as decongestion policies prevent firms from exploiting demand-side externalities that arise from search frictions. When no firm is allowed to operate in the core, average profits decline by 12%. The negative impact gets smaller as caps become less strict. This pattern holds for both high and low-quality firms, with the former experiencing a larger decline in profits from the introduction of caps.

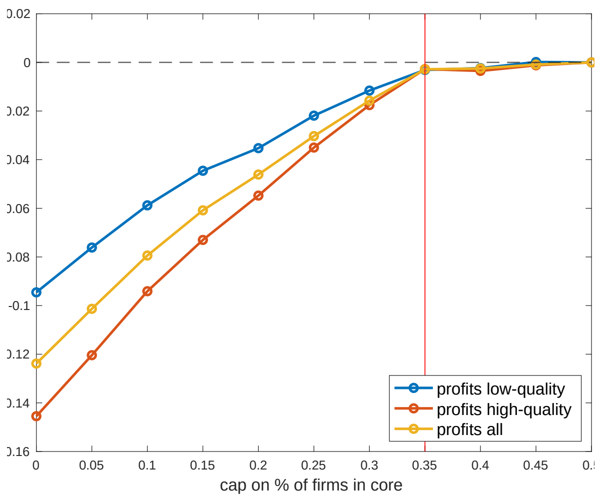
The impact of caps on average consumer welfare is muted, ranging between -1% and +1%.

[51] I still consider the choice of firms outside Kampala as exogenous, and assume that they are not affected by the cap.

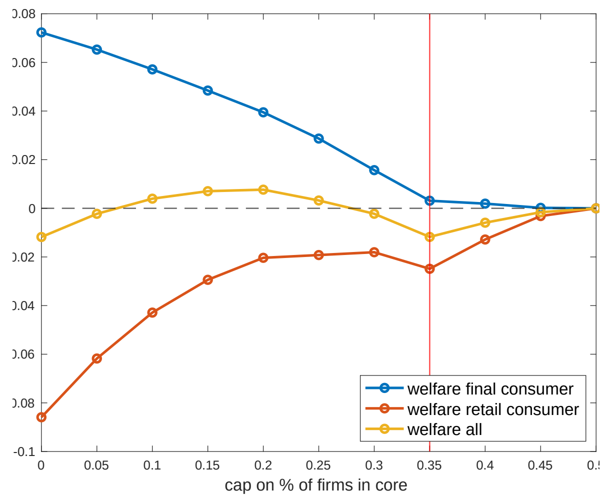
However, Panel B shows that these effects mask a substantial reallocation of welfare from retailers to final consumers. Final consumers benefit from the introduction of caps, with welfare increasing by 7.2% as firms are banned from the core. By contrast, the welfare of retail customers declines by 8.6%. The effect is stronger for stricter caps and flattens out as caps become less stringent.[52] The reason for these heterogeneous effects is that final consumers, who do not enjoy economies of scale in transport, would benefit from firms relocating outside the core and closer to residential areas. Retail customers, who benefit disproportionately from access to variety, would instead prefer to have as many firms as possible concentrated within the same location and would therefore be harmed by decongestion policies.

Figure 7: Changes in profits and welfare with caps

PANEL A: Change in firm profits



PANEL B: Change in consumer welfare



Notes: Figure 7 plots changes in firm profits (Panel A) and consumer welfare (Panel B) with respect to the baseline model as a function of the size of the cap. The size of the cap is measured as the share of firms allowed to operate in the core. The red vertical line at 0.35 indicates the point where the cap only becomes binding for low-quality firms.

Boda-boda ban In the final counterfactual, I analyze the implication of a policy banning motorcycle taxis (boda-bodas) from the core. The main reason why people use boda-bodas in Kampala, and particularly within the central part of the city, is to avoid congestion. To simulate the ban, I exploit the fact that Google maps in Uganda provides directions and driving time separately for cars and motorcycles (Figure A7). Differences in driving time between these two transport modes typically reflect the ability of two-wheelers to avoid traffic. I use the average difference in travel time between cars and motorcycles across

[52]As caps get closer to the baseline equilibrium, they only become binding for high-quality firms, thus altering the composition of businesses across locations.

locations in the the central district of Kampala to calibrate the increase in transport cost, which I apply to both customers and firm owners commuting to the core.[53]

The ban induces 9.8% of firms to relocate outside the core, with a stronger effect among high-quality businesses (12.7%). In Kampala, the ban is strongly opposed by firms operating in the core, who believe that it would lead to a reduction in footfall and therefore to a decrease in firms' profits. My estimates confirm this intuition: as a result of the ban, the profits of firms remaining in the core drop by 3.6%. However, businesses in the periphery gain from this measure, with profits increasing by 3.3%. Since the majority of firms operate outside the core, overall the policy leads to a 1% increase in average firm profits. The impact on consumer welfare is negligible (0.3%), but does not account for the potential benefits that consumers and workers might have from reduced decongestion and pollution.[54]

8 Conclusion

This paper presents a case study that highlights the importance of incorporating demand-side externalities resulting from consumer information frictions when modelling firms' location choices within cities. By combining unique data from a representative sample of garment firms and their customers in Kampala with a quantitative equilibrium model of consumer search and firm location, the paper quantifies the relevance of this channel.

There are three takeaways from this study. First, information frictions have a sizeable impact on firm agglomeration within the city, with important implications for the profitability of firms and consumer welfare. Second, the presence of information frictions restricts the ability of high-quality firms to attract customers and expand, favoring the survival of low-quality firms in the market. Third, policies solely focused on reducing agglomeration can disproportionately penalize high-quality firms by increasing consumers' costs of gathering

[53] For firm owners, I use the change in average travel time on a Wednesday morning at 9am (+6.8%). For customers, I take the difference in travel time on a Saturday at 9am (+5.2%). In doing so, I implicitly assume that car driving time would not be affected by the ban. Although this is a strong assumption, the impact of banning boda-bodas on congestion, and hence driving times, is ex-ante ambiguous. On the one hand, boda-bodas are known to not be very respectful of the rules of the road. Banning them from the most crowded part of the city could reduce congestion by allowing traffic to flow more easily. In addition, if effective at reducing the number of people travelling to the core, they would reduce overall congestion. On the other hand, individuals that would have otherwise travelled to the core by boda-boda will have to use a different transport mode: a car or a minibus. If these means of transport create more congestion per passenger than motorcycles, overall congestion will increase.

[54] For instance, Bassi et al. (2022a) show that by locating next to busy roads searching for customer visibility, they expose workers to substantial pollution. In addition, the counterfactual also neglects potential interactions with the impact the policy would have on the behavior of firms and consumers in other sectors, as well as the effects that the policy would have on motor-cycle taxis.

information.

The framework employed in this study can be extended to other contexts beyond low-income countries. For instance, it is applicable to settings in high-income countries where products are horizontally differentiated, and consumers still engage in in-person search. An example of this is the car market, which contunues to exhibit a strong spatial concentration of dealerships (Murry and Zhou, 2020; Moraga-González et al., 2022). Additionally, the framework could explain why sellers tend to concentrate on online platforms if searching on the internet is also costly.

The paper identifies several potential areas for future research. First, the existing literature on firms has primarily focused on supply-side constraints to explain why the firm size distribution in low-income countries continues to remain skewed towards small businesses (see Woodruff (2018) for a review). This study suggests that, by limiting the ability of good firms to build a customer base and grow, consumers' information frictions may play an equally important role. Demand-side constraints of this nature remain largely unexplored and merit further investigation.

Second, this paper highlights the interplay between firm agglomeration and the presence of bulk buyers in the market. While the presence and spatial distribution of bulk buyers are considered exogenous in this study, the counterfactual results indicate that firm agglomeration may incentivize intermediaries, such as retailers in this context, to enter the market. Examining the linkages between firms' location choices and intermediaries' entry decision could advance our understanding of the formation of supply chains (Grant and Startz, 2021).

A Appendix

A.1 Proofs and Derivations

A.1.1 Marginal effect of number of firms on demand

Under the assumption that mean utility is constant across firms in the same location, equation (3.4.6) can be rewritten as:

$$s^q_{ijl}(\mathbf{L},\mathbf{p}) = \frac{\exp(\frac{\bar{\delta}^q_l}{1-\sigma})\left(N_l \exp(\frac{\bar{\delta}^q_l}{1-\sigma})\right)^{q^\theta(1-\sigma)-1} \exp(-\tau_1 g(||z_i - z_l||))}{1 + \sum_{k=1}^{L}\left[\left(N_h \exp(\frac{\bar{\delta}^q_k}{1-\sigma})\right)^{q^\theta(1-\sigma)} \exp(-\tau_1 g(||z_i - z_k||))\right]} \tag{25}$$

Let $\Gamma = 1 + \sum_{k=1}^{L} \left[\left(N_h \exp(\frac{\bar{\delta}_k^q}{1-\sigma}) \right)^{q^\theta(1-\sigma)} \exp(-\tau_1 g(||z_i - z_k||)) \right]$ denote the denominator. Then:

$$\begin{aligned} \frac{ds_{ijl}^q}{dN_l} = \frac{1}{\Gamma^2} \Bigg[& \exp\left(\frac{2\bar{\delta}_l^q}{1-\sigma}\right)(q^\theta(1-\sigma)-1)\left(N_l \exp(\frac{\bar{\delta}_l^q}{1-\sigma})\right)^{q^\theta(1-\sigma)-2} \exp(-\tau_1 g(||z_i - z_l||))\Gamma \\ & - \exp\left(\frac{2\bar{\delta}_l^q}{1-\sigma}\right) q(1-\sigma)\left(N_l \exp(\frac{\bar{\delta}_l^q}{1-\sigma})\right)^{2q^\theta(1-\sigma)-2} \exp(-2\tau_1 g(||z_i - z_l||)) \Bigg] \\ & = (q^\theta(1-\sigma)-1)s_{ijl}^q s_{j|l}^q - q^\theta(1-\sigma){s_{ijl}^q}^2 \\ & = s_{ijl}^q s_{j|l}^q \left(q^\theta(1-\sigma)(1-s_{il}) - 1 \right) \end{aligned} \tag{26}$$

where the last expression can be derived by rewriting s_{ijl} as the product of s_{il} and $s_{ij|l}$.

A.1.2 Derivation of optimal prices

The FOC for firms' optimal prices are:

$$p_{jl}(\mathbf{p},\mathbf{J}) = c_l - \frac{Q_{ijl}(\mathbf{p},\mathbf{J})}{\partial Q_{ijl}(\mathbf{p},\mathbf{J})/\partial p_{jl}} = c_l - \frac{\int q_i s_{ijl}^q(\mathbf{p},\mathbf{J}) dF(q,z)}{\int q_i \frac{\partial s_{ijl}^q(\mathbf{p},\mathbf{J})}{\partial p_{jl}} dF(q,z)} \tag{27}$$

Omitting the arguments ($\mathbf{p},\mathbf{J}$) from now on, the derivative within the integral in the denominator is equal to:

$$\frac{\partial s_{ijl}^q}{\partial p_{jl}} = \frac{\partial s_{il}^q}{\partial p_{jl}} s_{j|l}^q + s_{il}^q \frac{\partial s_{j|l}^q}{\partial p_{jl}} \tag{28}$$

where, $\frac{\partial s_{il}^q}{\partial p_{jl}} = -\alpha q s_{ijl}^q (1 - s_{il}^q)$ and $\frac{\partial s_{j|l}^q}{\partial p_{jl}} = -\frac{\alpha q^{1-\theta}}{1-\sigma} s_{j|l}^q (1 - s_{j|l}^q)$. Putting everything together, the expression above becomes:

$$\frac{\partial s_{ijl}^q}{\partial p_{jl}} = -\frac{\alpha}{1-\sigma} q s_{ijl}^q \left[q^{-\theta} + s_{j|l}^q ((1-\sigma)(1-s_{il}^q) - q^{-\theta}) \right] \tag{29}$$

where the terms in square brackets is greater than zero. Plugging this into equation (3.A.4), the expression for optimal prices becomes:

$$p_{jl}^* = c_l + \frac{1-\sigma}{\alpha}\left(\frac{\int q s_{ijl}^q dF(q,z)}{\int q s_{ijl}^q [q^{-\theta} + s_{j|l}^q((1-\sigma)(1-s_{il}^q) - q^{-\theta})] dF(q,z)}\right) \tag{30}$$

A.1.3 Marginal effect of number of firms on optimal prices

Without loss of generality, I show how prices change in response to the number of firms operating in a location when firms face a single type of consumers. For ease of notation, I omit the exponent q. Optimal prices under this assumption are simply:

$$p_{jl}^* = c_l + \left(\frac{1-\sigma}{\alpha[q^{-\theta} + s_{j|l}^q((1-\sigma)(1-s_{il}^q) - q^{-\theta})]}\right) \tag{31}$$

Taking the total derivative of equation (3.A.7) with respect to the number of firms operating in the the location:

$$\frac{\partial p_{jl}^*}{\partial N_l} = \frac{\partial c_l}{\partial N_l} + \frac{d}{dN_l}\left(\frac{1-\sigma}{\alpha[q^{-\theta} + s_{j|l}^q((1-\sigma)(1-s_{il}^q) - q^{-\theta})]}\right) \tag{32}$$

Let $\tilde{S} = q^{-\theta} + s_{j|l}^q((1-\sigma)(1-s_{il}^q) - q^{-\theta})$. The derivative of this term with respect to the number of firms in the same location is:

$$\frac{d\tilde{S}}{dN_l} = \left(\frac{\partial s_{j|l}^q}{\partial p_{jl}^*}\frac{\partial p_{jl}^*}{\partial N_l} + \frac{\partial s_{j|l}^q}{\partial N_l}\right)((1-\sigma)(1-s_{il}^q) - q^{-\theta}) - \left(\frac{\partial s_{il}^q}{\partial p_{jl}^*}\frac{\partial p_{jl}^*}{\partial N_l} + \frac{\partial s_{il}^q}{\partial N_l}\right)s_{j|l}^q(1-\sigma) \tag{33}$$

Plugging this expression into equation (3.A.8) and rearranging:

$$\begin{aligned} &\frac{\partial p_{jl}^*}{\partial N_l}\left[1 + \frac{1-\sigma}{\alpha\tilde{S}^2}\left(\frac{\partial s_{j|l}^q}{\partial p_{jl}^*}((1-\sigma)(1-s_{il}^q) - q^{-\theta}) - \frac{\partial s_{il}^q}{\partial p_{jl}^*}s_{j|l}^q(1-\sigma)\right)\right] \\ &= \frac{\partial c_l}{\partial N_l} - \frac{1-\sigma}{\alpha\tilde{S}^2}\left(\frac{\partial s_{j|l}^q}{\partial N_l}((1-\sigma)(1-s_{il}^q) - q^{-\theta}) - \frac{\partial s_{il}^q}{\partial N_l}s_{j|l}^q(1-\sigma)\right) \end{aligned} \tag{34}$$

We focus on the case in which the agglomeration effect outweighs the competition effect, so that the demand for a firm's product is increasing in the number of firms operating in the same location: $\frac{\partial s_{ijl}^q}{\partial N_l} > 0$[55]. Under this scenario, the term in parenthesis on the right-hand

[55] If the competition effect is stronger than the agglomeration effect, then trivially prices are decreasing in the number of firms operating in the location.

side is negative, as $\frac{\partial s^q_{j|l}}{\partial N_l} < 0$, $\frac{\partial s^q_{il}}{\partial N_l} > 0$ and $q^\theta > \frac{1}{(1-\sigma)(1-s_{il})}$ (see equation (3.A.2)).

I now focus on the sign of the term in square brackets on the left-hand side:

$$\begin{aligned}
&\frac{\alpha}{1-\sigma}\left(q^{-2\theta} + s^{q\,2}_{j|l}((1-\sigma)(1-s^q_{il}) - q^{-\theta})^2 + 2q^{-\theta}s^q_{j|l}((1-\sigma)(1-s^q_{il}) - q^{-\theta})\right)\\
&\quad -\frac{\alpha}{1-\sigma}q^{1-\theta}s^q_{j|l}(1-s^q_{j|l})((1-\sigma)(1-s^q_{il}) - q^{-\theta}) + \alpha q s^{q\,2}_{ijl}(1-s^q_{il})(1-\sigma) \geq 0\\
\iff\ &\frac{\alpha}{1-\sigma}s^q_{j|l}((1-\sigma)(1-s^q_{il}) - q^{-\theta})\left(s^q_{j|l}((1-\sigma)(1-s^q_{il}) - q^{-\theta}) + 2q^{-\theta} - q^{1-\theta}(1-s^q_{j|l})\right)\\
&\quad +\alpha q s^{q\,2}_{ijl}(1-s^q_{il})(1-\sigma) \geq 0
\end{aligned} \tag{35}$$

A sufficient condition for this term to be positive is that $q < \frac{2}{1-s^q_{j|l}}$. If this condition holds, the sign of $\frac{\partial p^*_{jl}}{\partial N_l}$ depends on the term on the right-hand side of equation (3.A.10), where $\frac{\partial c_{jl}}{\partial N_l} < 0$ (supply-side externality), and the second term is positive as long as the agglomeration effect outweighs the competition effect (demand-side externality). Whether price increases or decreases in N_l therefore depends on the relative strength of the two externalities.

A.1.4 Existence and Uniqueness of price equilibrium

I use a result from Mizuno (2003) to find the conditions that guarantee the existence and uniqueness of a Nash-Bertrand equilibrium in the model. Let $D_j(p_j|\mathbf{p}_{-j})$ be the demand for product j in a differentiated products setting, and let $C_j(Q_j)$ be the firm j cost function. Mizuno (2003) proves that the following five conditions are sufficient for the existence of a unique price equilibrium:

(i) $D_j(p_j|\mathbf{p}_{-j})$ is strictly positive and strictly decreasing in p_j on R^n,

(ii) $D_j(\mathbf{p}) = D_j(\mathbf{p} + k\mathbf{u}^n)$ for all k, where u is the n vector whose elements are all unity,

(iii) $D_j(p^H_j|\mathbf{p}^H_{-j})D_j(p^L_j|\mathbf{p}^L_{-j}) \geq D_j(p^H_j|\mathbf{p}^L_{-j})D_j(p^L_j|\mathbf{p}^H_{-j})$ for $p^H_j \geq p^L_j$ and $\mathbf{p}^H_{-j} \geq \mathbf{p}^L_{-j}$,

(iv) $D_j(p_j|\mathbf{p}_{-j})$ is increasing in $\mathbf{p}_{-j}$ on R^n, OR, $C_j(Q_j) = c_jQ_j$, where $c_j \geq 0$

It is easy to see that the model satisfies conditions (i), (ii) and (iv). Condition (iii) can be re-written as:

$$\frac{D_j(p^H_j|\mathbf{p}^H_{-j}) - D_j(p^L_j|\mathbf{p}^H_{-j})}{D_j(p^L_j|\mathbf{p}^H_{-j})} \geq \frac{D_j(p^H_j|\mathbf{p}^L_{-j}) - D_j(p^L_j|\mathbf{p}^L_{-j})}{D_j(p^L_j|\mathbf{p}^L_{-j})} \tag{36}$$

which is satisfied if $\frac{\partial D_j(\mathbf{p})}{\partial p_j}/D_j(\mathbf{p})$ is increasing in p_{-j}, namely if:

$$\frac{\partial^2 D_j(\mathbf{p})}{\partial p_j \partial p_{-j}} \frac{1}{D_j(\mathbf{p})} - \frac{1}{D_j(\mathbf{p})^2} \frac{\partial D_j(\mathbf{p})}{\partial p_j} \frac{\partial D_j(\mathbf{p})}{\partial p_{-j}} \geq 0 \tag{37}$$

I focus again on the case of firms facing one type of consumers and show under what conditions inequality (3.A.13) is satisfied. With one type of consumers, the demand for firm j operating in location l is $s_{ijl}(\mathbf{L},\mathbf{p})$, where I omit the arguments $\mathbf{L},\mathbf{p}$ from now on. Equation (3.A.13) becomes:

$$\frac{\partial^2 s_{ijl}}{\partial p_{jl} \partial p_{-j}} - \frac{1}{s_{ijl}} \frac{\partial s_{ijl}}{\partial p_{jl}} \frac{\partial s_{ijl}}{\partial p_{-j}} \geq 0 \tag{38}$$

Where the price derivatives are:

$$(i) \;\; \frac{\partial s_{ijl}}{\partial p_{jl}} = -\frac{\alpha q}{1-\sigma} s_{ijl} \left(q^{-\theta} + s_{ij|l}((1-\sigma)(1-s_{il}) - q^{-\theta}) \right) \tag{39}$$

$$(ii) \;\; \frac{\partial s_{ijl}}{\partial p_{kl}} = -\frac{\alpha q}{1-\sigma} s_{ijl} s_{k|l}((1-\sigma)(1-s_{il}) - q^{-\theta}) \qquad for\ k \neq j \tag{40}$$

$$(iii) \;\; \frac{\partial s_{ijl}}{\partial p_{kh}} = \alpha q s_{ijl} s_{ikh} \qquad for\ k \neq j\ and\ h \neq l \tag{41}$$

Notice that, for firm j in location l an increase in the price charged by a different firm in a different location has a positive effect on demand (equation (3.A.17)). However, the impact of an increase in the price charged by a different firm in the same location is negative if $q^\theta > \frac{1}{(1-\sigma)(1-s_{il})}$ (equation (3.A.16)). This is because such an increase in prices makes the location less attractive, thus reducing demand. If the agglomeration force is strong, this effect can outweigh the lower within-location competition generated by an increase in the price charged by other firms.

I study the sign (3.A.14) separately for the effect of a change in the prices charged by firms in the same and in different locations.

(i) Change in price by firms in the same location

I start with the former case. The cross-derivative in equation (3.A.14) becomes:

$$\frac{\partial^2 s_{ijl}}{\partial p_{jl}\partial p_{kl}} = \left(\frac{\alpha q}{1-\sigma}\right)^2 s_{ijl}s_{k|l}((1-\sigma)(1-s_{il})-q^{-\theta})\Big(q^{-\theta}+s_{ij|l}((1-\sigma)(1-s_{il})-q^{-\theta})\Big)$$
$$-\frac{\alpha q^{1-\theta}}{1-\sigma}s_{ijl}s_{ij|l}s_{ik|l}((1-\sigma)(1-s_{il})-q^{-\theta})-\alpha q s_{ijl}s_{ik|l}(1-\sigma)(1-s_{il}) \tag{42}$$

And the second term in the inequality is equal to:

$$\frac{1}{s_{ijl}}\frac{\partial s_{ijl}}{\partial p_{jl}}\frac{\partial s_{ijl}}{\partial p_{kl}} = \left(\frac{\alpha q}{1-\sigma}\right)^2 s_{ijl}s_{k|l}((1-\sigma)(1-s_{il})-q^{-\theta})\Big(q^{-\theta}+s_{ij|l}((1-\sigma)(1-s_{il})-q^{-\theta})\Big) \tag{43}$$

Putting together these two expressions, the inequality in (3.A.14) becomes:

$$\frac{\partial^2 s_{ijl}}{\partial p_{jl}\partial p_{-j}}-\frac{1}{s_{ijl}}\frac{\partial s_{ijl}}{\partial p_{jl}}\frac{\partial s_{ijl}}{\partial p_{-j}} =$$
$$-\frac{\alpha q^{1-\theta}}{1-\sigma}s_{ijl}s_{ij|l}s_{ik|l}((1-\sigma)(1-s_{il})-q^{-\theta})-\alpha q s_{ijl}s_{ik|l}(1-\sigma)(1-s_{il}) \tag{44}$$

First, notice that this expression is negative when $q^{\theta} > \frac{1}{(1-\sigma)(1-s_{il})}$, which is the same condition upon which an increase in the price charged by a firm in the same location decreases the demand for a firm's products. If this condition holds, the existence and uniqueness of a price equilibrium is not guaranteed.

Equation (3.A.20) is positive, and hence a price equilibrium exists and is unique, if and only if:

$$q^{\theta} \leq \frac{1}{(1-\sigma)(1-s_{il})\Big(1+q^{\theta}(1-\sigma)s_{il}\Big)} \tag{45}$$

(ii) Change in price by firms in a different location

For an increase in the price charged by firms operating in different locations, inequality (A.15) becomes:

$$
\begin{aligned}
&-\frac{(\alpha q)^2}{1-\sigma} s_{ijl} s_{ikh} \left(q^{-\theta} + s_{ij|l}((1-\sigma)(1-s_{il}) - q^{-\theta} - s_{il}) \right) \\
&+\frac{(\alpha q)^2}{1-\sigma} s_{ijl} s_{ikh} \left(q^{-\theta} + s_{ij|l}((1-\sigma)(1-s_{il}) - q^{-\theta}) \right) \geq 0 \\
&\iff \frac{(\alpha q)^2}{1-\sigma} s_{ijl} s_{ikh} s_{il} \geq 0 \qquad (46)
\end{aligned}
$$

which is always true, as the term on the left-hand side is always ≥ 0.

A.1.5 Demand in the *no information frictions* counterfactual

In the *no information frictions* counterfactual described in Section 7.1, I assume customers can observe all product varieties at no cost prior to visiting a location (ω_l=0). With this assumption, the demand for firm j's product in location l becomes:

$$
\begin{aligned}
&s^q_{ijl}(\mathbf{L},\mathbf{p}) = Pr(u^q_{ijl} \geq u^q_{ihk}\ \forall\, h, k) \\
&= \frac{\exp\left(\frac{\delta^q_{jl}}{1-\sigma} - \frac{q^{-\theta}}{1-\sigma}(\tau_1 g(||z_i - z_l||) + \tau_2 \frac{N_l}{ar_l}) \right)}{\exp(u^q_0) + \sum_{k=1}^{N} \sum_{h=1}^{N_h} \exp\left(\frac{\delta^q_{hk}}{1-\sigma} - \frac{q^{-\theta}}{1-\sigma}(\tau_1 g(||z_i - z_k||) + \tau_2 \frac{N_k}{ar_k}) \right)} \qquad (47)
\end{aligned}
$$

Notice that the number of firms operating in the location N_l enters the numerator negatively (as a it increases search costs) and the denominator positively via the internal summation term. In this expression, there is no *market-size* effect, and having an additional competitor in the same location only decreases the demand for a firm's product via the *market-share* effect. The optimal price charged by the firm to type-q consumers from location i is simply:

$$
p^*_{jl} = c_l + \frac{1-\sigma}{\alpha q^{1-\theta}(1 - s^q_{ijl})} \qquad (48)
$$

where this expression is easily derived from $\frac{\partial s^q_{ijl}}{\partial p_{jl}} = -\frac{\alpha q^{1-\theta}}{1-\sigma} s^q_{ijl}(1 - s^q_{ijl})$ and $p^*_{jl} = c_l - s^q_{ijl} / \frac{\partial s^q_{ijl}}{\partial p_{jl}}$.

A.2 Location definition in the data

On the demand side, the underlying assumption for firms to belong to the same location is that customers who visit it are able to observe the characteristics of all the products sold in that location, but cannot observe products sold by businesses in neighbouring locations. To define the borders of a location, it is therefore important to take into account how far customers are willing to travel to search for products. On the supply-side, firms within the same location have the same production cost, as they benefit from the same amenities, and face the same outsourcing cost.

In the baseline estimation a location corresponds to a parish, with the exception of parishes in the core - Kisenyi I, Kisenyi II and Nakasero IV - which I consider one location. This choice takes into consideration the geographical dispersion of firms, which is important for customer search and outsourcing, as well as the political administration to which firms are subject, which can affect firms' production cost.

It is reasonable to assume that, once in a location, individuals in this setting walk around to search for products[56]. Firms that belong to the same location must therefore be of walking distance to one another. The average size of Kampala parishes is 2.03 square-kilometer, which is a reasonable area to walk. In addition, within parishes firms tend to cluster along main roads or in marketplaces (Figure A8). This implies that (i) the effective distance customers must walk to visit all firms within the location is lower than the parish area; (ii) clusters tend to be contained within the parish borders, and relatively far from other clusters. This is not true for the core area, where the majority of firms are part of the same cluster located at the border of the three parishes (Figure A8 in blue). In fact, Density-Based Spatial Clustering of Applications with Noise algorithms (DBSCAN) with a distance radius above 25 meters generate a unique cluster for the three central parishes.

Although a pure spatial algorithm could be used to generate "search" clusters, it is important to also take into consideration the supply-side of the model. In Uganda, parishes are under the administration of a chief who is responsible for tax collection, the implementation of national and local government policies and, in some instance, the settling of land disputes. All these factors are part of the amenities that firms face in a given location, and likely to affect their productivity.

Considering the trade-off between geographical dispersion and production amenities, the identification of parishes as locations is a reasonable choice. In Appendix A.5.2, I conduct a

[56]In the customer survey, 61% of individuals report walking to the location where they purchased a product, 37% report travelling by public transport, and less than 1% drove a car.

robustness exercise where I consider firms in the core to be separate locations. I also plan to re-estimate the model using a pure spatial algorithm for assigning firms to location to verify the robustness of my finding to alternative definitions.

A.3 Details on data for demand estimation

A.3.1 Imputation of customers' location

Before describing the imputation procedure, it is important to understand what are the correlates of missing location. Table A7 shows the results from a regression of a dummy for missing location on a number of transaction and firm characteristics, controlling for parish (Column 1) and firm fixed effects (Column 2). I consider both transactions for which no information about the location is provided, and transaction for which only the region was recorded as missing.

Reassuringly, Column 1 shows that attrition is uncorrelated with the total amount of the transaction, the number of items purchased, and the firm's average number of daily customers and average daily revenues, suggesting that busier firms are not more likely to omit customers' origin. However, the table shows that location is more likely to be missing for final than for retail customers. A possible explanation is that retail customers are 21% more likely to have had interactions with the firm in the past, increasing the chances that the firm owner is aware of the origin of the customer. In Column 2, I include firm fixed effects to look at variation in reporting within the firm. Once again, I find no significant relationship between size of the transaction and attrition, but find that firms are less likely to report the origin of retail customers. Overall, these results show that, conditional on customer type, transactions for which customer origin is observed are not different from those for which location is missing in terms of observable characteristics. This suggests that they can be safely used to impute missing locations.

I rely on the structure of the model for imputation. Equation (3.4.5) shows that, within a location, the share of type q consumers buying products from a given firm is independent of the origin i of the customer. This is because mean utility δ_{jl}^{q} is independent from the customer's origin. This implies that, conditional on customer type and firm location, the distribution of customers' origin should not differ across transactions for which location is reported, and those for which it is missing in terms. Therefore, I randomly assign customers to locations proportionally to the share of customers origin observed in the data, conditional on customer type and firm location.

A.3.2 Data for outside option

The estimation of retailers' outside option requires data on the total number of final and retail customers purchasing tailoring products in each parish. For final customers, I constructed this measure using data from the 2020 Ugandan National Panel Survey, which contains information on households' annual consumption of clothing. This information was used to calculate the share of households in Kampala purchasing tailoring products over a three days period (the length of the transaction data), assuming consumption is uniformly distributed over the year. The corresponding number at the parish level was then calculated by multiplying this share by the number of households per parish from 2014 Ugandan Population Census.

For retail customers, total number of customers was constructed combining data from the 2010 Ugandan Census of Business Establishments and the customer survey. Data from the latter shows that on average retail customers purchase products from a firm every 3.5 days. I therefore considered the total number of retailers as the pool of customers. I considered retail customers all firms operating in one of the following sectors: wholesale of textiles, clothing and footwear (ISIC 4641), retail sale of clothing, footwear and leather articles in specialized stores (ISIC 4771) and retail sale via stalls and markets of textiles, clothing and footwear (ISIC 4782). I used the 2010 Census, which includes geo-localized data, to compute the number of firms in these sectors operating in each parish.

A.4 Mystery shoppers script

"Hi, I am looking for someone who can sew for me a short dress for my niece who is 13 years old girl. I got your contact from a friend who recommended you, and so I would like you to make the dress. Specifically, I would like you to reproduce this dress."

- Show the picture of the garment to be replicated to the tailor (Figure A9).

"As you can see, the dress has a gathered skirt, a baby collar and puff sleeves finished with elastics. On the back, it should have a long zip, not buttons. I bought some fabric that I would like you to use for this dress."

- Show the fabric to be used to the garment.

"Would you be able to do it? These are the measurements for the dress."

- Show the measurements to the respondent. Do not leave them with him/her.

"I am going to travel to Soroti in 3 days, and I would need the dress by then, so I can bring it with me. I will leave at [time at which you placed the order]. Would you be able to make it by then?"

If not: *"Why not? When would be the earliest you can make it?"*

- Accept the time frame given by the respondent as long as it is within the next 2 weeks.

"At what price would you be willing to sew this dress for me?"

- Reduce the price by 20%. If the reduced price is above 30,000UgSh, say that 30,000UgSh is the maximum you can offer.

"Would you be willing to sew it for me for [rounded price]?"

- Accept whatever price is then given by the respondent, as long as it is below or equal to 30,000UgSh. If not, thank the respondent and leave without buying anything.

"How much should I give you as a deposit?"

- Agree to deposit up to 50% of the price if the respondent insists.

"Can I please have a receipt, so that I can remember how much the balance is? Ok, then I will come and collect it on [earliest day available]. If you happen to finish the dress before, please give me a call at this number [phone number]"

- Give your phone number to the respondent. Leave the fabric and thank him/her. End of the exercise.

A.5 Robustness

A.5.1 Endogenous prices

To ensure that estimates of price elasticity are not biased by endogeneity, I re-estimate demand using instrumental variables for prices to identify the price coefficient α. Given estimates of $\{\sigma, \theta, \tau_1, \tau_2\}$, I can solve for the vector of mean utilities δ^q_{jl} that matches observed and predicted market shares from the model. Berry (1994) proves that, for discrete choice models satisfying standard regularity conditions, such vector exists.

Mean utilities take the following form: $\delta^q_{jl} = \beta \mathbf{x}_j - \alpha p_{jl} q^{1-\theta} + \xi_j$. Because prices might be endogenous, I instrument for them using (i) a cost-shifter: the average price paid by the firm for one meter of fabric; (ii) a BPL instrument - the share of high-quality firms in the same location (excluding the firm itself). I use transaction prices as output and control for product type fixed effects. The first and second stage of the IV estimation are shown in Table A8.

In the first stage, the instruments are strong predictors of prices. Contrary to what one would expect from a standard demand model, but consistent with the presence of demand-side externalities in my setting, the share of high-quality firms in the same location has a positive impact on prices. In the second stage, α is equal to -0.092, which falls within the confidence interval of the estimated coefficient in the baseline estimation.

A.5.2 Alternative location definition

I test the robustness of the demand and supply parameters to an alternative definition of locations in the model. In the baseline scenario, a location corresponds to a parish, with the exception of the three parishes in the core - Kisenyi I, Kisenyi II and Nakasero IV - which are considered one location. I re-estimate the model allowing for the three central parishes to be separate locations. The results are presented in Table A9. The parameters are similar to those in the baseline estimation with one location in the core.

A.5.3 Allowing for dynamics

To model presented in Section 4 is static. Although this is partly justified by the persistence of firm-customer relationships and firm location choices in the data, I conduct a robustness check to test the plausibility of this assumption by adding a second period to the model. In the first period, consumers do not observe any of the match-specific shocks ε and decide what firms to buy products from as described in Section 4.2. However, upon visiting a location, consumers observe the ε-shocks for all firms operating in the selected location. Hence, in a second period, consumers would have to decide whether to go back to the same location (in which case they would buy from the same firm, as it would still be yielding the highest utility), or visit a different location.

Let $l^{(1)}$ and $j^{(1)}$ be the location and the firm chosen in the first period. In the second period, consumers will choose the location yields the highest expected utility:

$$l^{(2)} = \arg\max_{k \in L} \{u^q_{il^{(1)}j^{(1)}}, \max_{k \neq l^{(1)}} V^q_{ik}\} \tag{49}$$

where V^q_{ik} is given by equation (3.4.4). I simulate a second period using the estimated parameter and compute the share of customers who would choose to search a different location. I find that only 17% of customers would switch to a different location in a subsequent period, while 83% would go back to the initial firm. This suggests that a static model captures the core of the consumer search process and hence of firm choice of location.

A.6 Model extension with entry

A.6.1 Set-up

In this section I present an extension to the model that allows for firm entry and exit. Let E be the number of potential entrants, which is finite and known to all firms, and let J be the corresponding number of firms actually entering the market. Potential entrants simultaneously choose whether to enter the market and in which location to place the firm. I assume that firms observe their type (high or low-quality) prior to making the entry decision. To enter, firms must pay an entry cost EC_j. If they decide not to enter the market, they make zero profits. Firms' total profits are given by the following expression:

$$\Pi_{jl}(\mathbf{L},\mathbf{p}) = \pi_{jl}(\mathbf{L},\mathbf{p}) - \tau_3 g(||z_j - z_l||) - e_{jl} - EC_j \tag{50}$$

In equilibrium, each entrant expects to earn non-negative profits. Given the assumption on the unobserved preference shock e_{jl}, one can follow the same steps outlined in Section 4.4 to derive the probability of a firm entering the market:

$$Pr_j(Entry|\boldsymbol{P}^*) = \frac{\sum_{l=0}^{N} \exp\left(\sum_{\boldsymbol{l}_{-j}} \left(\pi_{jl}(l_j, \boldsymbol{l}_{-j}) \prod_{h \neq j} P_h^*(l_h) E(Pr_h(Entry)|\boldsymbol{P}^*) - \tau_3 g(||z_j - z_l||) - EC_j \right)/\mu \right)}{1 + \sum_{k=0}^{N} \exp\left(\sum_{\boldsymbol{l}_{-j}} \left(\pi_{jk}(k_j, \boldsymbol{l}_{-j}) \prod_{h \neq j} P_h^*(l_h) E(Pr_h(Entry)|\boldsymbol{P}^*) - \tau_3 g(||z_j - z_k||) - EC_j \right)/\mu \right)} \tag{51}$$

where the term at the numerator is a weighted average of firms' expected profits across all locations.[57] Notice that the expected number of entrants depends on conjectured firm location in equilibrium, which in turn depends on the expected number of entrants. To solve for both entry and location, one should solve for the augmented system of equations (3.4.19) and (3.A.26) for all potential entrants. This is beyond the scope of this paper.

[57]Notice that when firms are heterogeneous, entry probability does not only depend on the total number of entrants, but also on their identity.

A.6.2 Estimation of entry costs

Under the assumption that the expected number of entrants is exactly equal to the number of entrants in the data, it is possible to recover firms' entry costs following the approach outlined in Seim (2006). In the model, firms are only heterogeneous in quality and the location where the owner resides. Let E_{ot} be the potential number of owners of type $t = \{H, L\}$ from location $o = \{1, ..., L\}$. The number of actual entrants is given by $J_{ot} = Pr_{ot}(Entry|\boldsymbol{P}^*) \times E_{ot}$, where the probability of entry is given by expression (A.26), conditional on the number of entrants observed in the data. To recover entry costs, one must know the number of potential entrants from each location. I assume that this number is equal to 0.1% of the population and that there is an equal share of low and high-quality type owners in each location (i.e. each parish). Given the conditional choice probabilities associated with firms' equilibrium strategies $\mathbf{P}^*$, which is estimated in the baseline model, it is possible to solve the pair of equations (3.4.19) and (3.A.26) to obtain entry costs. First, notice that entry costs can be expressed as:

$$-\frac{EC_{ot}}{\mu} = \log Pr_{ot}(Entry|\boldsymbol{P}^*, J) - \log(1 - Pr_{ot}(Entry|\boldsymbol{P}^*, J))$$
$$- \log\left[\sum_{k=0}^{N} \exp\left(\left(\sum_{\boldsymbol{l}_{-j}} \pi_{tk}(k_t, \boldsymbol{l}_{-j}, J) \prod_{h \neq j} P_h^*(l_h) - \tau_3 g(||z_o - z_k||)\right)/\mu\right)\right] \tag{52}$$

The logarithm of the probability of entry can be re-written as: $\log Pr_{ot}(Entry|\boldsymbol{P}^*, J) = \log J_{ot} - \log E_{ot}$. Plugging this expression into (A.27), I obtain:

$$-EC_{ot} = \mu \times \Bigg\{ \log J_{ot} - \log(E_{ot} - J_{ot})$$
$$- \log\left[\sum_{k=0}^{N} \exp\left(\left(\sum_{\boldsymbol{l}_{-j}} \pi_{tk}(t_j, \boldsymbol{l}_{-j}, J) \prod_{h \neq j} P_h^*(l_h) - \tau_3 g(||z_o - z_k||)\right)/\mu\right)\right]\Bigg\} \tag{53}$$

Given the estimated parameters, the number of potential and actual entrants and $\mathbf{P}^*$, entry costs can be directly calculated from (A.28). I estimate average entry costs for low-quality and high-quality firms to -272.76 and -557.50 respectively. I use entry costs to calculate the share of firms that, *at the current number of firms in the market*, would be making negative profits and hence be better off exiting in the counterfactual scenarios. This is simply given by $(1 - Pr_{ot}(Entry|\boldsymbol{P}^*, J))$.

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Table A1: Relocation

	% of firms
No Relocation	
Never relocated	54.4
Relocation to Core	
Periphery to core	5.32
Outside Kampala to core	6.16
Relocated within core	11.3
Relocation to Periphery	
Core to periphery	2.83
Outside Kampala to periphery	7.82
Relocated within periphery	12.1

Notes: Table A1 reports the percentage of firms that never relocated, relocated to the Core and relocated to the Periphery since being established.

Table A2: Quality score in core and periphery

	(1) Quality score	(2) Quality score
Core	0.185**	0.196
	(0.090)	(0.141)
Years of experience		0.009
		(0.006)
Years of experience X Core		0.001
		(0.010)
Interviewer FEs	✓	✓
Number of Observations	494	494

Notes: Robust standard errors in parentheses. * $p < .10$, ** $p < .05$, *** $p < .01$. Table A2 reports the results from a regression of the quality score the firm obtained in the mystery shoppers exercise on a dummy equal to one for firms in the core, the owner's year of experience and the interaction of these two variables. The quality score is a standardized measure with mean 0 and variance 1. All regressions include interviewers' fixed effects.

Table A3: Correlation between transaction and mystery shopper prices

	(1)	(2)	(3)
	Transaction price (USD)		
Mystery shoppers price (USD)	0.925***	0.808***	1.077***
	(0.122)	(0.100)	(0.065)
Quality score			0.461***
			(0.111)
Product FEs		✓	✓
Number of Observations	2,571	2,571	2,541

Notes: Robust standard errors in parentheses. * $p < .10$, ** $p < .05$, *** $p < .01$. Table A3 reports the results from a regression of prices from the transaction records on prices from the mystery shoppers exercise. Regressions in Columns 2 and 3 include products' fixed effects. Column 3 controls for the firm's quality score from the mystery shoppers exercise, where the quality score is a standardized measure with mean 0 and variance 1.

Table A4: Correlates of mystery shoppers prices

	(1) Mystery shoppers price (USD)
Quality score	0.241***
	(0.0761)
Customer care (0-10 rating)	0.0533
	(0.0678)
Greeted upon entering the firm	-0.249
	(0.460)
Given undivided attention	0.268
	(0.354)
Pleasant closing comment	-0.451
	(0.395)
Tidiness of premises (0-10 rating)	-0.0475
	(0.0656)
Cleanliness of premises (0-10 rating)	0.164**
	(0.0741)
Product ready by delivery date	-0.202
	(0.199)
Offered something to come back	0.543
	(0.515)
Told to advertise firm	0.147
	(0.279)
Interviewer FEs	✓
Parish FEs	✓
Average price (USD)	5.579
Number of Obs	529

Notes: Robust standard errors in parentheses. * $p < .10$, ** $p < .05$, *** $p < .01$. Table A3 reports the results from a regression of prices from the mystery shoppers exercise on a number of quality measures collected during the same exercise. All regressions include interviewer and parish fixed effects. The quality score is a standardized measure with mean 0 and variance 1. When not otherwise specified, the explanatory variable is equal to 1 if someone in the firm took the indicated action and 0 otherwise.

Table A5: Model fit - Observed and simulated inputs

Parish		Land (h)	Labor (ℓ)
Bwaise II	*Data*	*6.050*	*1.931*
	Sim	5.890	2.333
Kamwokya II	*Data*	*5.450*	*1.650*
	Sim	5.466	1.594
Kasubi	*Data*	*5.003*	*2.246*
	Sim	4.736	2.711
Katwe I	*Data*	*1.750*	*1.500*
	Sim	1.989	1.045
Kibuye II	*Data*	*2.857*	*2.429*
	Sim	2.671	2.619
Kisenyi III	*Data*	*3.450*	*2.450*
	Sim	3.823	0.948
Kisugu	*Data*	*7.750*	*1.938*
	Sim	7.347	2.943
Mbuya I	*Data*	*9.394*	*2.314*
	Sim	9.194	2.941
Naguru I	*Data*	*3.862*	*2.353*
	Sim	4.192	1.224
Core	*Data*	*2.671*	*2.321*
	Sim	2.808	2.167
Nakivubo-Shauriyako	*Data*	*4.533*	*2.467*
	Sim	3.282	3.606
Wandegeya	*Data*	*2.478*	*2.696*
	Sim	2.217	2.896

Notes: Table A5 shows the average amount of land and labor employed by firms across different locations from the firm survey data (Data) and the simulated data (Sim). Land is measured as the size of the firm premises in square-meters. Labor is measured as the total number of internal (including the firm owner) and external workers employed by the firm.

Table A6: Estimated productivity parameters

Parish	**Productivity** (A_l)
Core	18.12
Periphery	
Bwaise II	5.541
Kamwokya II	9.636
Kasubi	8.400
Katwe I	24.47
Kibuye II	7.596
Kisenyi III	19.08
Kisugu	4.096
Mbuya I	2.652
Naguru I	9.164
Nakivubo-Shauriyako	5.806
Wandegeya	14.05

Notes: Table A6 reports the estimated productivity parameters A_l for the different parishes.

Table A7: Correlates of missing customer origin

	(1) Missing origin	(2) Missing origin
Total transaction value (USD)	0.000	-0.000
	(0.001)	(0.000)
Quantity for customer	0.000	-0.000
	(0.000)	(0.000)
Retail customer	-0.073*	-0.069***
	(0.034)	(0.023)
Average of daily customers	-0.041	
	(0.039)	
Average daily revenues (USD)	-0.001	
	(0.001)	
Parish FEs	✓	
Firm FEs		✓
Number of Observations	2,569	2,569

Notes: Standard errors clustered at the parish level in parentheses. * $p < .10$, ** $p < .05$, *** $p < .01$. Table A7 reports the results from a regression of a dummy equal to 1 if the origin of the customer is missing in the transaction records on a number of firm characteristics. The regressions in columns 1 and 2 include parish fixed effects and firm fixed effects respectively.

Table A8: Estimated price coefficient allowing for endogeneity

	(1) Transaction price	(2) Delta
Panel A: First Stage		
Cost of fabric (1 meter)	0.647***	
	(0.192)	
Share high-quality firms	8.383***	
	(2.450)	
Panel B: Second Stage		
Transaction price		-0.092**
		(0.038)
Product FEs	✓	✓
Number of Observations	608	608

Notes: Robust standard errors in parentheses. * $p < .10$, ** $p < .05$, *** $p < .01$. Table A8 reports the results from a two-stage least squares regression of the mean utility δ on instrumented prices from transaction records. The instrumental variables for prices are the average cost paid by the firm for 1 meter of fabric and the share of high-quality firms operating in the same location (excluding the firm itself).

Table A9: Estimated parameters with separate central parishes

	Parameter	Estimate
PANEL A: Demand		
Price (USD)	α	-0.054
Quality final customers	β_f	0.083
Quality retail customers	β_r	0.761
Taste shocks correlation	σ	0.499
Quantity multiplier	θ	0.382
Travel cost	τ_1	-0.134
Within location search cost	τ_2	-0.0002
PANEL B: Supply		
Labor share	δ	0.693
Outsourcing cost	T	-1.230
Productivity Core	A_{core}	16.530
Productivity Periphery (mean)	A_{per}	13.695

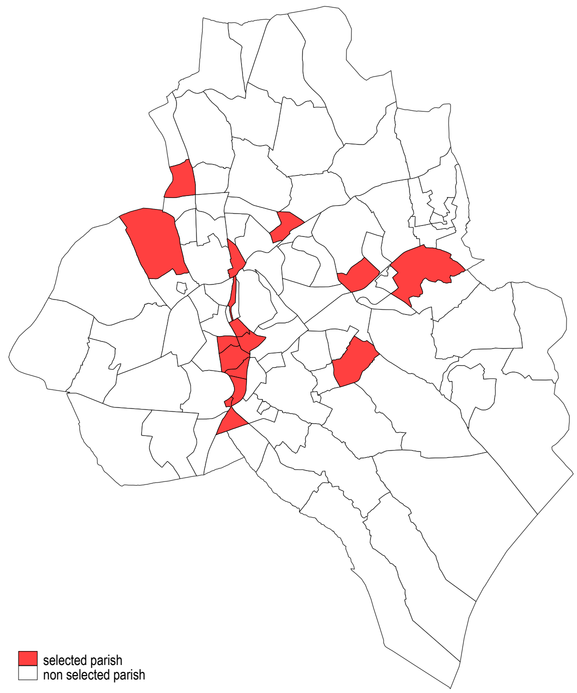
Note: Table A9 shows point estimates for the model parameters in a model that considers the three parishes in the core, namely Kisenyi I, Kisenyi II, and Nakasero IV as separate locations.

Figure A1: Typical dresses

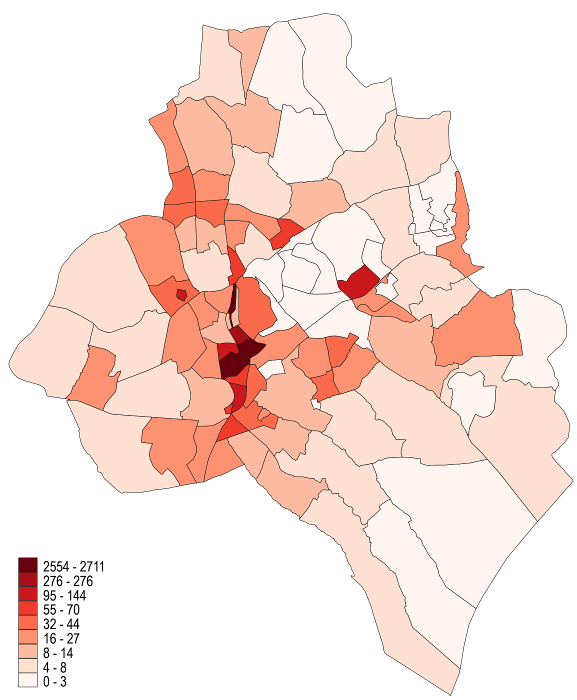
Note: Figure A1 shows the typical variety of dresses sold by four different firms in the sample.

Figure A2: Selected locations

PANEL A: Selected Parishes

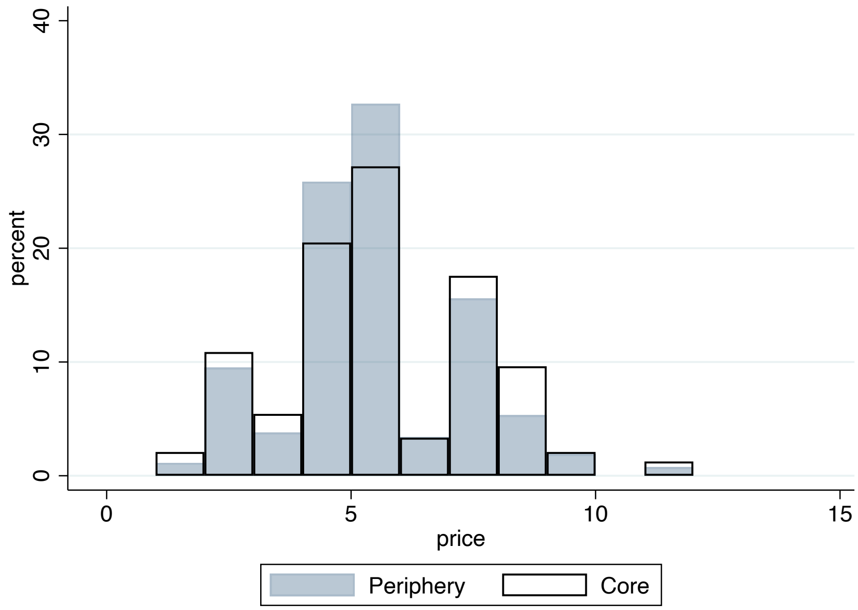


PANEL B: Garment firms per square-km



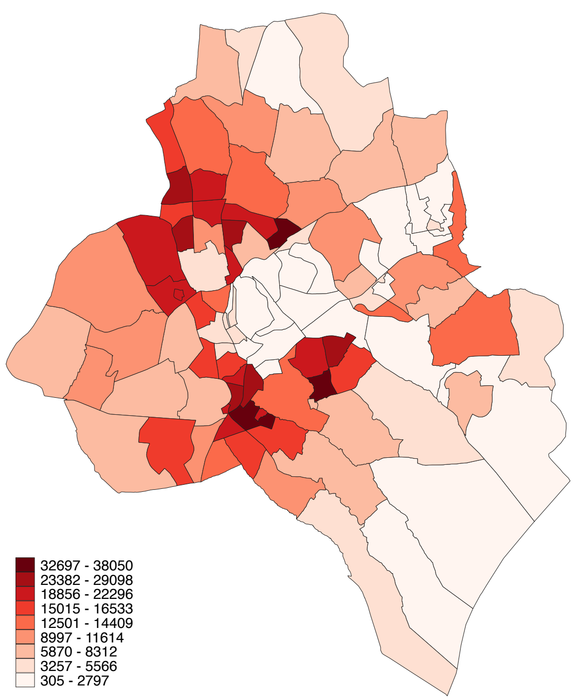
Note: Panel A of Figure A2 shows the 14 parishes selected for the study. Panel B shows firm density, measured as the average number of firms per square-kilometer, across the 96 parishes in Kampala. Firm density is computed using data from the 2010 Census of Business Establishments.

Figure A3: Distribution of mystery shoppers prices



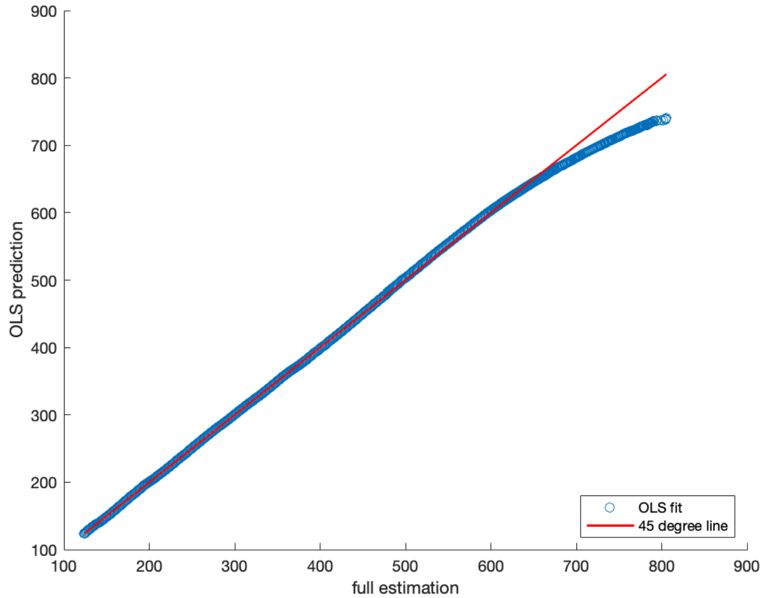
Note: Figure A3 shows the distributions of prices (in USD) from the mystery shoppers exercise separately for firms in the core (in black and white) and the periphery (in light-blue).

Figure A4: Kampala population distribution



Note: The figure shows population density, measured as the average number of inhabitants per square-kilometer, across the 96 parishes in Kampala. Population density is computed using data from 2014 National Population and Housing Census.

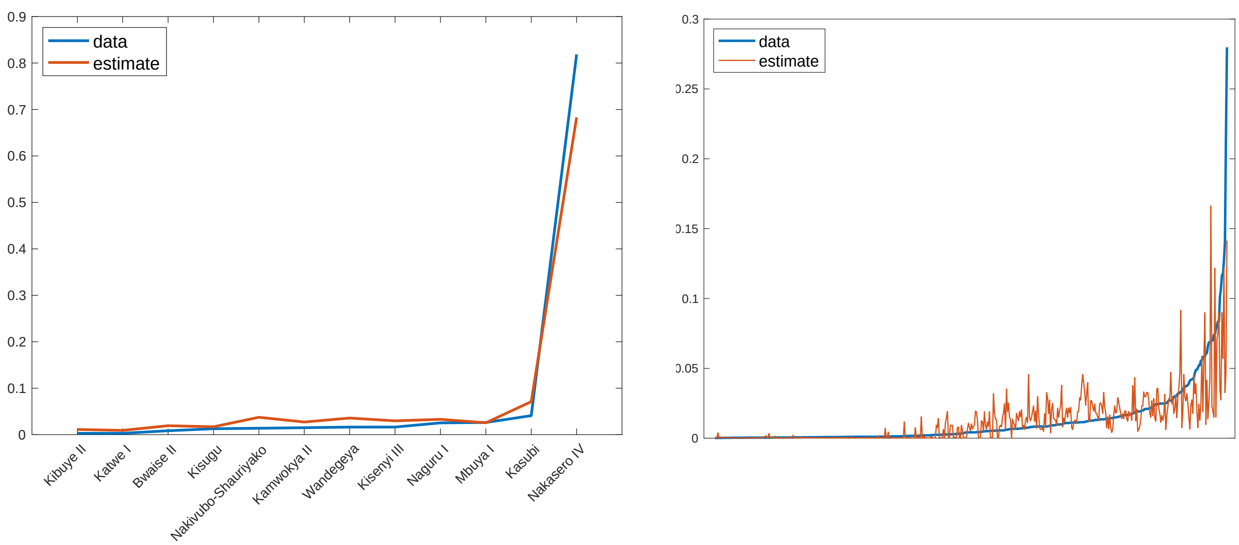
Figure A5: Profits from full model solution vs. OLS prediction



Note: Figure A5 plots estimated firm profits from the full model solution (which requires the computation of the Nash-Bertrand pricing game for each spatial configuration of firms) against profits interpolated using the OLS regression reported in the second line of Equation 3.5.5.

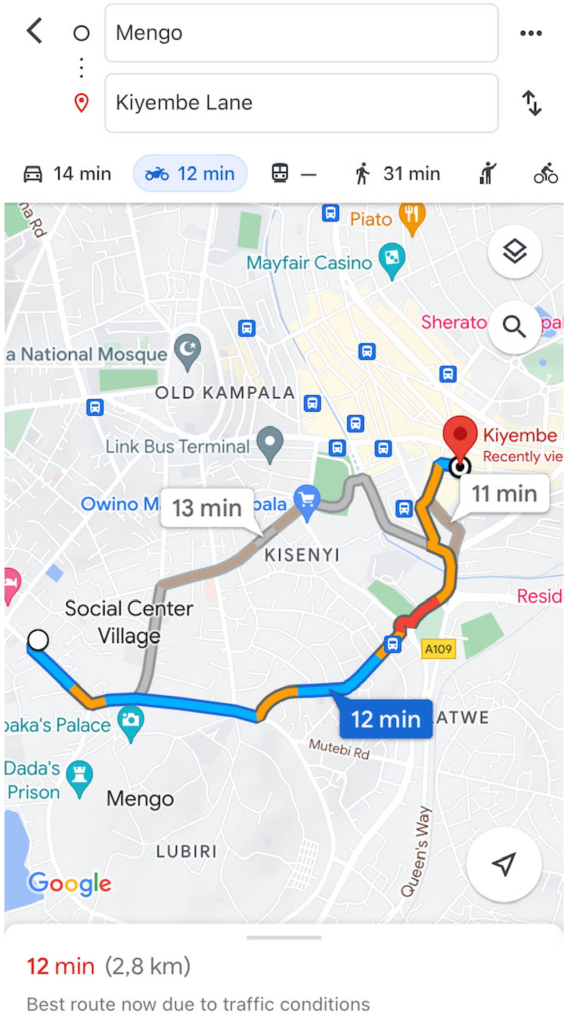
Figure A6: Model fit - Observed and simulated demand

PANEL A: Location shares **PANEL B: Within location firm shares**



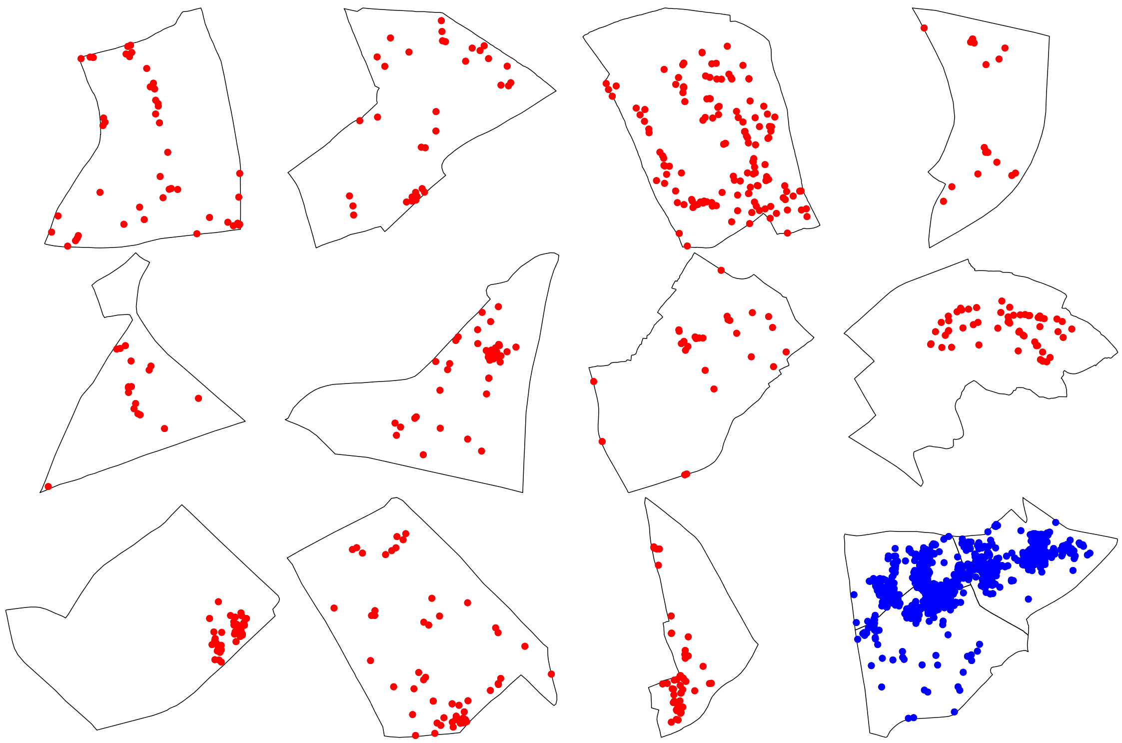
Notes: Figure A6 shows location shares and within location firm shares from the firm transaction records (in blue) and the simulated data (in red).

Figure A7: Google Maps travel time by car and motorcycle



Note: Figure A7 shows an example of the travel time indicated by Google separately for cars and motorcycles. Differences in travel times between the two means of transport take into account average speed (which may reflect motorcycles' ability to avoid congestion), as well as the possibility for motorcycles to utilize routes that are inaccessible to cars.

Figure A8: Firm Location within Periphery and Core



Note: Figure A8 shows the exact location of all the firms listed in the 11 peripheral parishes (in red) and the 3 parishes in the core (in blue). In the figure, each dot represents a firm.

Figure A9: Product commissioned by mystery shoppers

Note: Figure A9 shows the product commissioned by the mystery shoppers to firms. This picture was shown to firms, who were asked to exactly replicate the dress. Photo credit: Mariajose Silva Vargas.

Figure A10: Quality scoring sheet

BUSINESS ID:				
	ASSESMENT CRITERIA	SCORING GUIDE	MAX SCORE	SCORE
1	DARTS	Dart of 4 ”long by 1”wide	3	
		Correctly sewn	3	
		Press to the right side	2	
		Position of the Dart observed	2	
2	COLLAR	Peter Pan/Baby Collar	5	
		Fixed correctly round the neckline	5	
3	SLEEVES	Sleeved Well Gathered	3	
		Sleeve Length 8”	2	
		Round sleeve 14”	2	
		Correctly fixed on Bodice	3	
4	SKIRT	Skirt length 18”	2	
		Skirt Equally Gathered	2	
		Neatly fixed to Bodice	2	
		Correct Seam Allowance	2	
		Skirt bottom shaped round	2	
5	ZIP	Zip attached to Centre back seam	4	
		Right color of Zip	3	
		Right length of Zip	3	
6	SEAM	Right Seam Allowance “Y2-1”	3	
		Correctly Pressed	3	
		Neatly Finished Edges	4	
7	HEM	Hemmed bottom of Dress	2	
		Hem lin-2ins	1	
		Hem Neatly sewn	3	
		Hem well pressed	4	
8	MEASUREMENTS	Cross Back 15”	2	
		Bust - 34”	2	
		Waist – 28”	2	
		Top to Waist –14”	2	
		Full Length – 32”	2	
9	FINISHING	No hanging threads seen	3	
		Dress Pressed with no wrinkles seen	3	
		No chalk marks	2	
		Dress clean	2	
10	PACKAGING	Dress Neatly and Correctly Folded	5	
		Packed in Bag	3	
		Branded Packaging	2	

Note: Figure A10 shows the assessment sheet used to evaluate the quality of the products purchased in the mystery shoppers exercise. Each product is evaluated according to 10 assessment criteria, which define the macro-categories for the assessment. Each criteria is then sub-divided in smaller categories which define the task that should have been accomplished by the firm. Each task is associated with a maximum score. The maximum scores add up to 100.

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