Final report

International Growth Centre

Understanding productivity dispersion

Evidence from a new survey of manufacturing firms in Uganda

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1. Introduction

Differences in income per capita across countries are mostly accounted for by differences in aggregate total factor productivity (Hall and Jones, 1999; Caselli, 2005). These differences are also present at the firm level: firms in less developed countries have, on average, much lower labor productivity. However, there is substantial **productivity dispersion** within developing countries: indeed, the low average productivity in developing countries is mostly driven by a thick left tail of small and unproductive firms, while relatively productive firms exist even in the poorest countries (see Tybout 2000; Bloom et al 2010; Hsieh and Klenow 2009; Hsieh and Olken 2014).

The presence of some relatively high productivity firms even in the least developed countries is encouraging: while productivity differences across countries are in principle very difficult to address – since they are possibly due to different institutions or rule of law – productivity differences **within countries** might be driven, in principle, by factors more amenable to external intervention. However, to design such interventions, it is first and foremost necessary to understand what explains within-country productivity dispersion. To our knowledge - as we describe in more detail below - there is a lack of suitable data to provide an answer to this question.[1]

In this project, we fill this evidence gap by designing and implementing a representative survey of small, medium, and large firms, and their employees, in urban and semi-urban Uganda. We collect granular information that allows us to precisely measure productivity differences across firms, and – most importantly – to understand **how high productivity and low productivity firms differ**. The results from the survey generate new key facts about the determinants of productivity dispersion in Uganda, a large developing country in one of the least studied areas of the planet, Sub-Saharan Africa.

In this report we describe the survey and the key descriptive findings from the new data. We then outline how these are informing the design of a model of firm behaviour that we are currently working on to interpret the descriptive evidence and generate policy counterfactuals.[2] Finally, we discuss the main policy implications as well as the next steps, which include a new pilot study to assess the effectiveness of different types of policy interventions in stimulating productivity in urban Uganda.

[1] On the need for more and better data on firms in developing countries see Bloom et al (2014). Two notable exceptions are the work on management practices by Bloom et al (2013) and on technology adoption by Atkin et al (2017).

[2] This final report builds on an academic paper that we are currently writing as an additional output from this IGC project. See Bassi et al (2019).

2. **Sampling**

In this section we describe our sampling frame in terms of sector selection, geographical coverage and firm coverage.

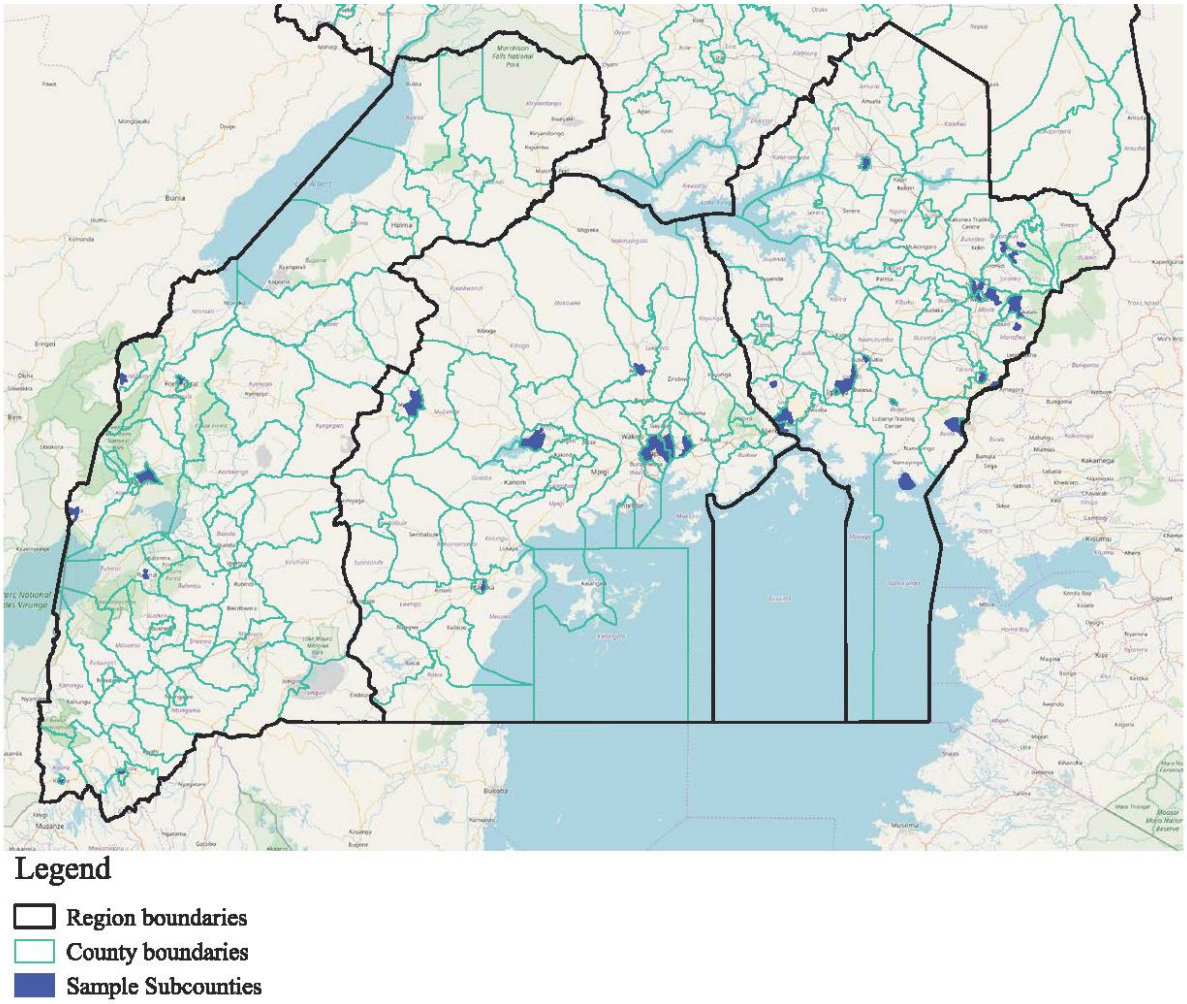
Sector selection. We focus on **manufacturing firms**, where output, inputs and productivity are easier to measure. Our main goal was to compare productivity across firms and understand why some firms manage to produce more output than others. For this reason, we aimed to select sectors where firms of different productivity can co-exist, and that are not dominated by subsistence entrepreneurs with little potential for growth. Further, we targeted sectors that have a sufficiently large number of firms. Due to data availability, we worked with size as a proxy for productivity for the purpose of sampling. In particular, using the 2010 Census of Business Establishments, we computed for each 4 digit ISIC manufacturing sector the sectoral share of overall Ugandan manufacturing employment in firms with five or more workers. We then ranked sectors based on this measure. We excluded from the ranking sectors with farms and those dominated by a small number of very large firms (such as sugar). Among the remaining ones, we selected the three with the highest share of employment in large firms, namely: i) **Metal fabrication**; ii) **Carpentry** and iii) **Grain milling**. These are our final three sectors for the survey. These are also sectors that the Ministry of Trade of Uganda, that is our partner for this project, is focusing on in terms of industrial policies to increase productivity of Micro, Small and Medium Enterprises (MSMEs). So by collecting data on these sectors we are also able to provide relevant insights and policy advice to the Ministry about the role of skills and mechanization as drivers of productivity, which is something that the Ministry is particularly interested in.

Geographic Coverage. To keep survey costs manageable, we focused on geographical areas with relatively high firm and population density. Geocoding and plotting all the firms in the 2010 Census reveals that production is spatially concentrated in urban areas. Therefore, we focused our survey on **urban and semi-urban areas** of three of the four regions of Uganda (**Western, Central, and Eastern**).[3] We excluded rural areas as they have low population and firm density. Similarly, we excluded the Northern region as that is the one with the lowest firm and population density. We then sampled 52 sub-counties for the survey, as calculations based on the 2010 Census suggested this was the number of sub-counties needed to achieve (in expectation) our target sample of 1,000 firms in the survey. The sampling was stratified by population and by whether a sub-county is part of the region of Kampala, the capital city. The actual survey was then conducted within all urban and semi-urban parishes of each of the 52 selected sub-counties, for a total of 177 parishes. Figure 1 shows the geographical scope of the survey.

Firms. To identify the firms eligible for our survey, we conducted a full **listing** of all the firms in our three sectors of interest in the sampled parishes. We decided not to use the existing Census of Business Establishments for the listing because it would not have allowed us to capture firm entry since 2010 and because we suspect the Census might have under-sampled small, informal establishments. We then randomly extracted firms from the listing to be included in the **final survey sample**. To make sure our final sample included enough large firms, we oversampled firms with five or more employees from the listing.

[3] Specifically, we gathered parish-level data on population density, and used a cutoff of 750 individuals per square mile (following the U.S. census), to classify a parish as "urban" or "semi-urban".

Figure 1: Geographical scope of the survey



3. Survey Instruments

Our measurement exercise was at the establishment level, and involved two types of tools: (i) a questionnaire for firm **owners**; (ii) a questionnaire for firm **employees**.

Both questionnaires were carefully designed specifically for this survey, through a long process of piloting and conversations with firm owners and their employees. Here we provide a summary of each main component of the instruments.[4]

Owner/Manager Questionnaire. We interviewed the owner, if present/available, or alternatively the main manager of the firm. We collected information on: demographics; general and sector-

[4] While the survey instrument is newly designed, we have adapted some questions from previous work conducted by the research team in Uganda (see Bassi and Nansamba 2019; Alfonsi et al 2019). In addition, other important references are the work by Chris Woodruff, David McKenzie and co-authors, such as McKenzie (2012), De Mel et al (2009; 2018), McKenzie and Woodruff (2017).

specific skills; tasks/operations performed; time-use; expectations about the future; perceived constraints. We also asked the owner/manager about: firm performance (both firm-level and product-level performance); capital, labor and intermediate input usage; firm network relationships; borrowing behaviour. Importantly, we collected very detailed information on the entire production process for a set of pre-specified products, as described in more detail below.

Employees Questionnaire. We interviewed all employees within the firm involved in the production of the pre-specified products. We collected information on: demographics; general and sector-specific skills; past work-experience; tasks/operations; time-use; involvement in the production processes for the pre-specified products and time required to perform each production step.

While our survey design and sampling frame builds on the recent work of other scholars in this area of research,[5] we believe we go beyond and extend their work in a number of ways.

First, in terms of sampling frame, we target the **entire firm size distribution** in three important sectors within manufacturing. This is something novel as most related studies focus on microenterprises with less than 2 employees (see for example De Mel et al 2018). Important exceptions are Hardy and McCasland (2017), Bassi and Nansamba (2019) and Alfonsi et al (2019) who target larger firms also, but none of these surveys is representative of the entire firm size distribution. By collecting data on a representative sample of firms along the entire firm size distribution we are able to make statements about the role of firm size and scale as a driver of labor productivity, which is something central to our research objectives.

Second, in terms of survey design, we contribute to the literature on firm growth in developing countries by collecting rich information on how firms produce output in these sectors. Something that sets us apart from other related studies is that we collect information on the entire **production process** for key products. Specifically, through extensive piloting activities in collaboration with the Ugandan Industrial Research Institute, we identified one core product in each sector that is commonly produced in Uganda. For example, in carpentry the core product is the 2-panel door. We then broke down the production process for our core products into a series of production steps, and designed a survey module where we asked detailed questions about: (i) whether firms conduct each step, and (ii) how each step is conducted, in terms of the specific combination of capital and labor used.

In particular, for each step we asked which specific machines are used, and which employees work on that step. We can then link this information to an extensive machine and employee roster including detailed information on the characteristics of both machines and employees. Just to highlight a few unique features of our data on production processes, for each machine we collected information on: weekly hours used; whether it is owned or rented; purchase (or rental) cost; where the machine was purchased/where it is rented from; country of production; age; current value; expected remaining life. For each employee as well as the firm owner we collected information on: machine-specific skills; cognitive and non-cognitive skills; time-diaries where we measure hour by hour the time spent doing different activities in the last work-day before the survey.

[5] See for example the surveys in De Mel et al (2018), Hardy and McCasland (2017), Alfonsi et al (2019), Bassi and Nansamba (2019) and Jensen and Miller (2018).

Such wealth of information on how the capital and labor input is combined in production allows us to study differences in how the same output is produced across firms in the same sector. This is key to isolate the sources of productivity differences across firms, and something that we believe puts us at the frontier of measurement of firm productivity in developing countries.

4. Survey implementation

The survey started in September 2018 and was completed in July 2019. The survey was conducted by BRAC NGO, in partnership with the Ministry of Trade of Uganda. Ethical approval by MUREC (Mildmay Uganda Research Ethics Committee) was also obtained. As Table 1 shows, more than 2,900 firms were identified in the initial listing. Of these, more than **1,100 firms** were then selected to be interviewed in the full survey. At both the listing stage and the full survey stage we experienced very high rates of compliance with the listing/survey: of the firms eligible to be included in the listing 93% actually answered the screening questions for the listing activities. Of the firms selected for the final survey, 99% answered the survey. The very **high rate of compliance** at both the listing and the survey stage limits concerns related to the representativeness of our final sample.

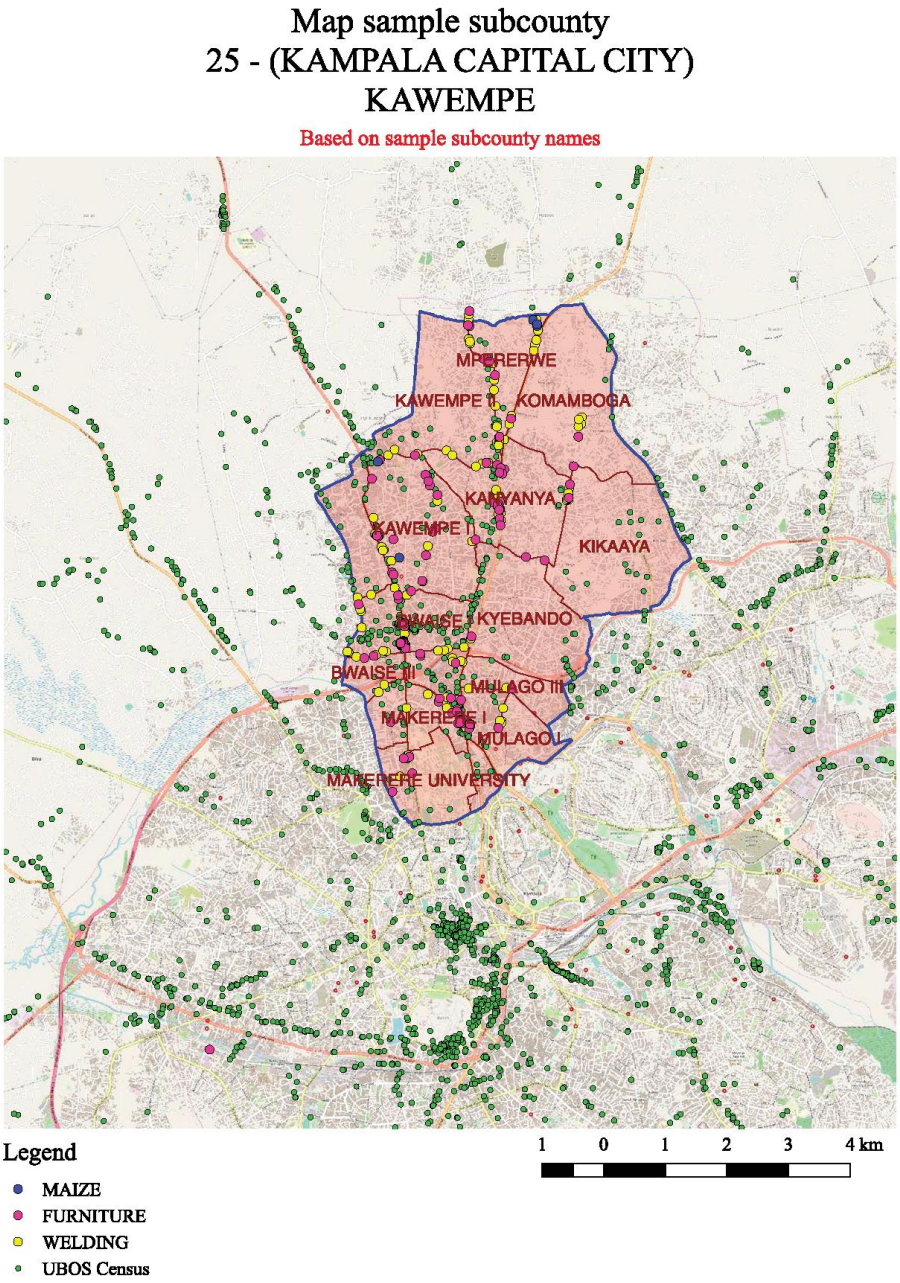
Table 1: **Sample Size**

	N. Firms identified in listing	N. Firms screened for survey eligibility	N. firms selected for survey	N. firms interviewed in survey
	(1)	(2)	(3)	(4)
All sectors	2,916	2,702	1,127	1,115
Carpentry	1,487	1,381	518	516
Metal fabrication	1,171	1,092	441	433
Grain Milling	258	229	168	166

Notes: The listing was conducted in 177 parishes in 52 sub-counties. Firms screened for survey eligibility are those who completed the questions in the listing. Firms were selected for the full survey from the listing by random extraction.

We sampled at the subcounty level, and within subcounty we only included in the study urban and semi-urban parishes. Within each parish, enumerators were instructed to do a listing of all the firms. It was very important, to preserve sample-representativeness, that our enumerators only covered the sample areas. Using the GPS location of interviewed firms as showing in our data, we verify that they have been successful in this. For example, in Figure 2, we show the map for one of our sampled sub-counties: Kawempe. The map shows that all the contacted firms are within the sample parishes (the shaded area in pink). It is also worthwhile to notice that this is not due to the lack of firms outside of our sample area. In fact, when we plot in the same map (in green) all the firms in our sectors of interest from the 2010 census, we see that many of them fall outside of our sample area.

Figure 2: Map of one Sample Sub-County



Notes: sample parishes are the pink-shaded area. Blue, yellow, and pink dots are the firms contacted by our enumerators. Green dots are firms present in the 2010 Firm census.

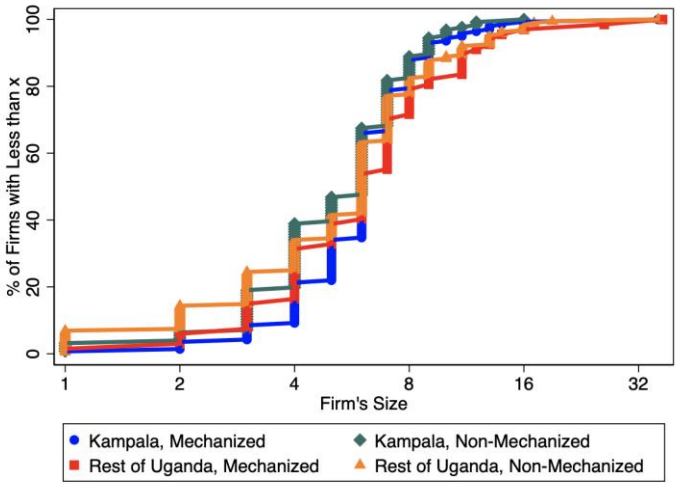
It is also worthwhile to emphasize that our enumerators have been successful in surveying both relatively smaller and larger firms, which is very important given our focus on firm heterogeneity. Figure 3A shows the CDF of size for firms in the carpentry sector, that is our most common sector.[6]

[6] Results are similar for the other two sectors, but here focus on furniture for brevity.

We divided the firms into four groups, based on location (Kampala vs Non-Kampala) and number of different types of machinery used (Mechanized vs Non-Mechanized). Reassuringly, Figure 3A shows that even within each group, we have interviewed both larger and smaller firms.

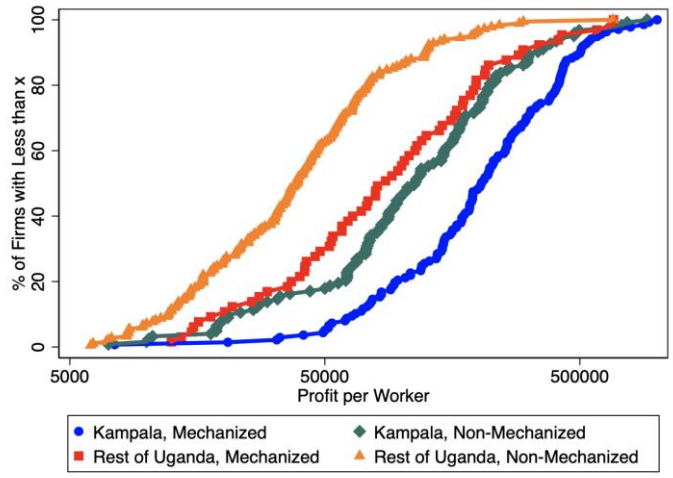
Similarly, it is reassuring to notice that we covered both high and low profitability firms. Figure 3B plots the CDF of profit per workers for the same four groups. The overall ratio between the 90th-10th percentiles of profitability is more than 10. Even within group the 90th-10th ratio is well above 5.

Figure 3A: CDF of Firms Size



Notes: we plot the CDF of firm size for the carpentry sector separately for four groups of firms, based on location and mechanization. Kampala firms are in the Kampala and Wakiso Districts. Mechanized firms are those that use in production more than 6 different types of machinery, that is, more than the sample median number of machine types.

Figure 3B: CDF of Firms Profit per Worker



Notes: we plot the CDF of firm profit per worker (in UGX) within the carpentry sector for the same four groups of firms previously described.

5. Main Findings

We now describe the main research findings from the project. We present these as key facts that emerge from the survey, and we then outline how we are using these key facts to inform a model of firm behaviour and conduct policy counterfactuals in an academic paper that we are currently working on. For the sake of brevity, we discuss mostly the results for carpentry, which is our most common sector, but we point to the results in metal fabrication and grain milling as well where useful to highlight the main differences with carpentry and why these are informative. Finally, we discuss the next steps with the project.

The first finding is that the economic environment in these sectors is characterized by **many small firms producing similar products using similar production steps**. The average number of employees is less than five, and this is true across the three sectors. Production is concentrated around some key products: for instance, as shown in Figure 4A, 70%-80% of firms in carpentry produce beds and doors – the two most common products. And among firms producing doors, Figure 4B shows that over 70% of firms produce the 2-panel door, which is our core product for carpentry (that was pre-specified). In addition, the great majority of firms are engaged in most of the pre-specified production steps for the core product, as shown in Figure 5 for carpentry. The patterns in metal fabrication and grain milling are similar.

Figure 4A: Share of firms in carpentry producing a given product

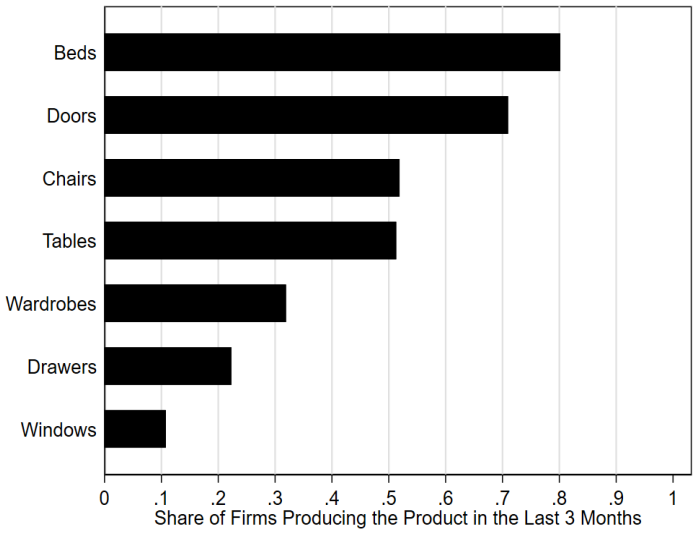
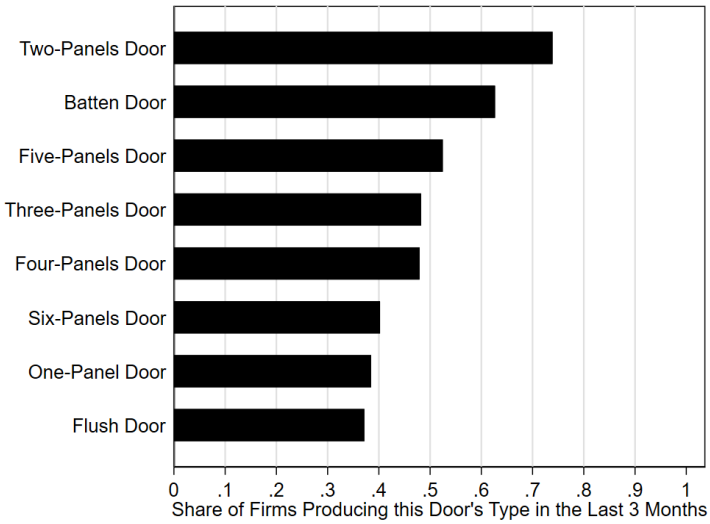
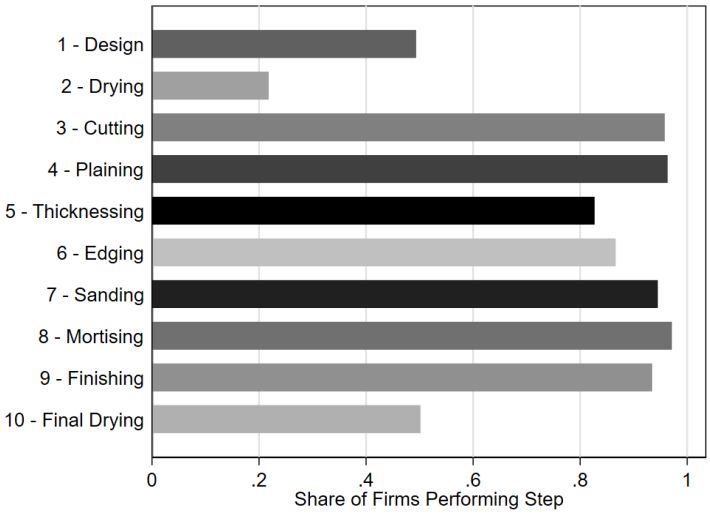


Figure 4B: Share of firms in carpentry producing a given door type



Notes: The figures report the share of firms surveyed in the carpentry sector which produced various types of standard products (listed on the y-axis) in the 3 months preceding the survey. Figure 4A shows that firms within the sector typically produce similar products. Figure 4B shows that two panel doors, which is our main product for the carpentry sector, is produced by the majority of door-producing carpentry firms. The product was selected before the start of the survey.

Figure 5: Share of firms performing a given step for the production of 2-panel doors



Notes: For each of the three sectors covered in the survey (i.e. carpentry, metal fabrication and maize milling) we selected one core product (ex-ante) and categorized its production process into a series of steps. The steps were compiled prior to the roll-out of the survey. The main product identified in the carpentry sector was two-panel doors which is produced by the majority of door-producing carpentry firms. The Figure displays the share of carpentry firms (on the x-axis) that perform the identified steps (enumerated on the y-axis) in the production of two-panel doors. It shows that most firms producing the same product employ very similar production steps.

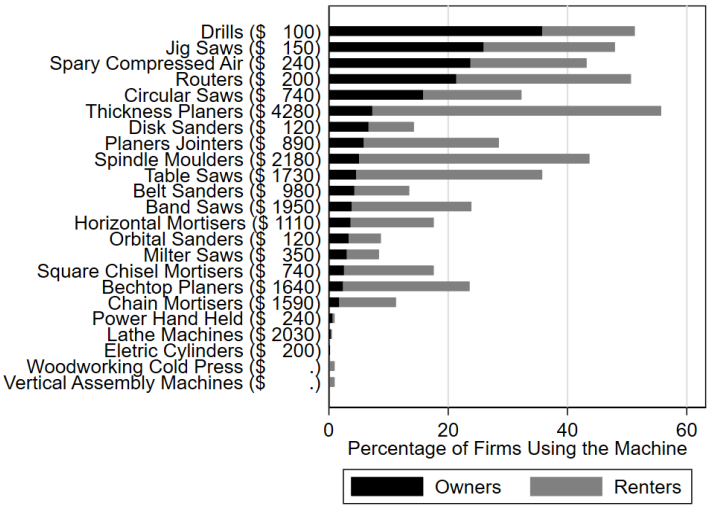
The second finding is that **production is spatially concentrated in firm clusters**. We can use our initial listing of firms to study the spatial concentration of firms in our data. This reveals that

in carpentry and metal fabrication there are approximately six firms of each sector per square mile; the density is lower but still significant for grain milling with over two firms per square mile. The clustered nature of economic activity in these sectors can be appreciated visually in Figure 2 above, which maps the distribution of firms from the listing in one of our sampled sub-counties. Indeed, we see that firms tend to cluster together around major roads.

The third key finding is that even though firms produce similar products following similar production steps, there is **large variation in their labor productivity**: our data for carpentry reveals that firms at the 75th percentile of the distribution of profits per worker, our measure of labor productivity, are over five times more productive than firms at the 25th percentile of the distribution. The results are similar for metal fabrication and grain milling.

The fourth finding is that **usage of modern machines varies widely across firms and is strongly correlated with productivity differences**. Figure 6 shows that while some machines are used by most firms, others are used only by a small share of firms. So despite producing similar products with similar production steps, some firms do so using modern machines while other firms tend to rely more on manual tools and labor. In Figure 7 we compare the importance of machines to other drivers of profitability. We show that machine usage is a more important determinant of profitability than other potential factors that have been the focus of most firm-level interventions, namely firm size and skills of either workers or managers.[7]

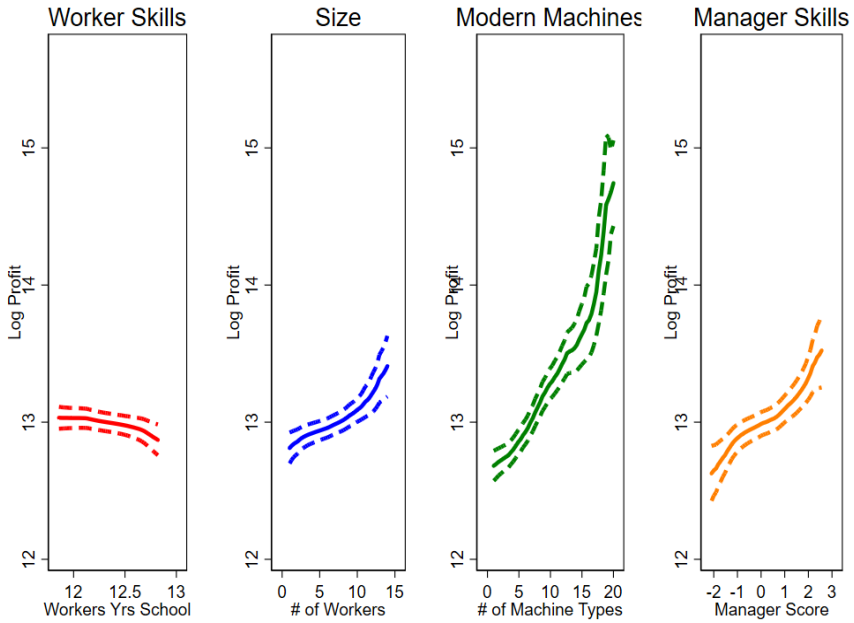
Figure 6: Usage of modern machines by own vs rent



[7] While we do not find a positive correlation between worker skills and firm profits, we do estimate positive Mincerian returns to skills for workers in terms of earnings. For instance, in carpentry we estimate that an additional year of education of the worker is associated with around a 2% increase in monthly worker earnings. This result is robust to the inclusion of various worker- and firm-level controls, including also sub-county of firm operation. The magnitudes of the Mincerian returns to education for workers are similar in the other two sectors. Since higher skilled workers earn higher wages, then this can explain why worker skills do not predict firm profits. On the other hand, the great majority of managers are also owners of the firm, which in turn can explain the positive relationship between manager skills and profitability.

Notes: The Figure decomposes the percentage of firms that use a machine in the carpentry sector among those firms that own the machine (black) and those that rent it (grey). Machines used in the production of the core products in the various sectors (e.g. two-panel doors in the case of carpentry) are listed on the y-axis, whereas the percentage of firms using these machines is displayed on the x-axis. The graph shows that in carpentry there is clear evidence of an active rental market for machines. Similar graphs for metal fabrication and grain milling show instead that the rental market is very thin in those sectors. These graphs are not reported for brevity but are all available upon request.

Figure 7: Determinants of profitability



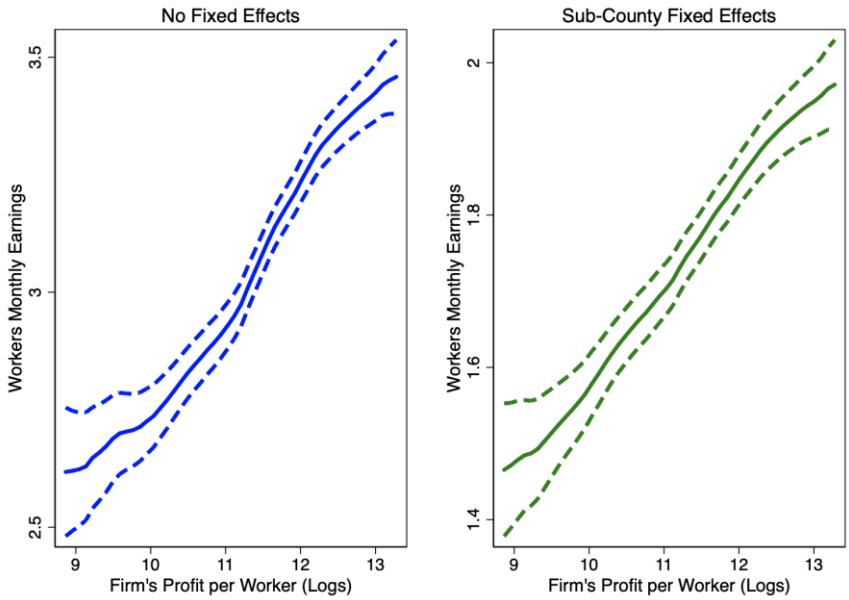
Notes: we run a firm-level regression of monthly profits as a function of (i) average years of schooling of the workers in the firm, (ii) number of workers in the firm, (iii) number of different machine types used by the firm, and (iv) an aggregate managerial practices score calculated following de Mel et al (2018). These four variables are all included simultaneously in the same regression. We then report a non-parametric plot of the sum of the regression residuals and the fitted values for each of the four variables considered. For example, the third panel shows the plot – across firms – of the sum of the fitted values and the regression residuals for the number of machine types, as a function of the number of machine types.

The fifth key finding is that **both managers and workers benefit from higher firm profitability**. Figure 8 shows that, conditional on observable characteristics, workers employed in more profitable firms earn higher monthly earnings. On average, a one percent increase in profits per worker is associated with a 0.15 percent increase in monthly earnings, and this is precisely estimated. The relationship holds also within sub-county; hence it is not simply driven by spatial heterogeneity.

Our sixth finding is that **machines are by nature an indivisible good and most firms need at most one of each type**. Our data reveals that most firms use only one unit of each type of machine, and they do so for only a few hours per week. This result is not surprising given the small size of most firms and the fact that many machines have a high production capacity. Indeed, as shown in Figure 6, most of these machines are very expensive for these firms. As an example, thickness planers are the most common type of machine in carpentry, but they cost $4,280 on average – more

than 30 times the median monthly profit ($125). The fact that machines are large and expensive suggests that there are clear economies of scale driven by the capital input in carpentry. Machines are also very expensive in grain milling, but less expensive in metal fabrication.

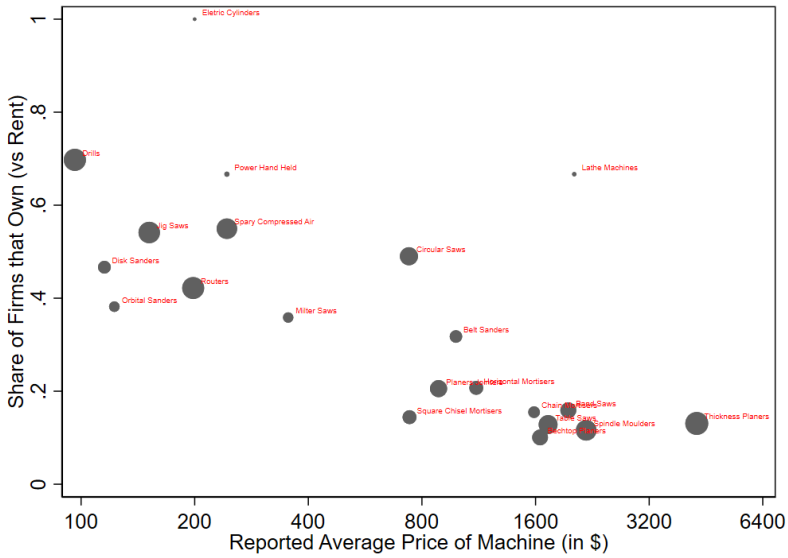
Figure 8: Relationship Between Firms' Profit and Workers' Earnings



Notes: we run a worker-level regression of the log of monthly earnings on numbers of schooling years, age, age squared, and log of profits per worker of the firm they are currently working at. We run the regression both with and without sub-county fixed effects. We then report a non-parametric plot of the sum of the fitted values for firm's profit per worker and the regression residual on firm's profit per workers itself.

The seventh finding is that **a rental market for machines has emerged that partially allows firms to achieve scale collectively**. As expected, given the indivisibility of machines and excess capacity, a rental market has emerged. Figure 9 shows that in carpentry, especially for the most expensive machines, many firms get access to machines through rentals. The nature of the rental market however is peculiar: large machines (e.g. thickness planers) are very difficult to move given their size, and thus firm owners need to bring their inputs (e.g. wood) to the premises of the firm where the machines are located, sustaining possibly large time and transport costs. As a result, the rental market seems to be plagued by high transaction costs and possible inefficiencies. We note that the rental market is instead much less developed in metal fabrication and grain milling. The reason why it is less developed in metal fabrication is that machines are less expensive and have lower capacity there, which makes it easier for firms to buy them and utilize them to a fuller extent. In grain milling instead, even though machines are expensive and large, they are used more intensively by each individual firm so that there is less excess capacity that can be rented out.

Figure 9: Share of firms that rent vs own as a function of machine price



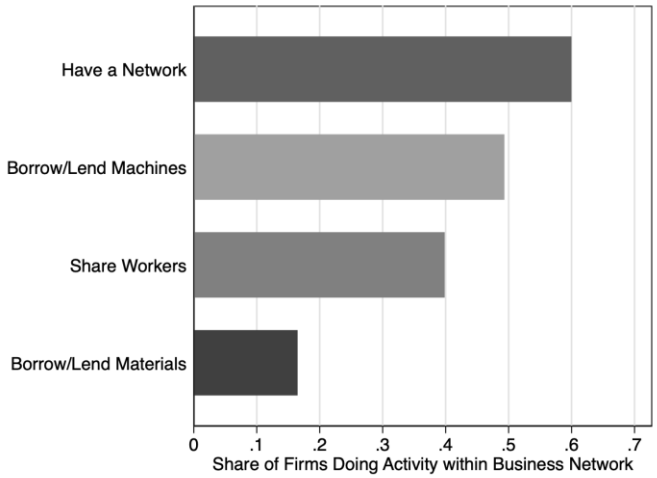
Notes: This Figure shows that rentals are most common for more expensive machines in the carpentry sector. It depicts a strong negative correlation between the share of firms that own (vs. rent) machines (shown on the y-axis), and the reported average price of machines in US dollars (shown on the x-axis). Data points for the various machine types are scaled in proportion to their usage by carpentry firms in the production of two-panel doors. Similar graphs for the metal fabrication and grain milling sector show that the rental market is much less developed there, so that the share of firms owing the machine is closer to one along the entire distribution of machine prices. These graphs are not included for brevity but are all available upon request.

The eighth key finding is that **firms are organized in tight informal cooperative networks**. In Uganda, as in most developing countries, firms are often organized in clusters that produce similar products. Such clusters of firms are in close geographical proximity and are often organized in informal networks. Firms cooperate through such networks: indeed, our survey reveals that it is common for firms within the network not only to discuss business-related matters but also to borrow money as well as to share machines and workers with each other, as shown in Figure 10. Our survey did not specifically ask managers why they choose to locate near other firms in the same sector. The data from our network section however suggests that firms benefit from being part of a cluster through the lending and borrowing activities they engage in with the firms located nearby. Such cooperative networks enable the emergence of a rental market for machines for example.

The final key fact is that **lack of access to machines** is perceived as a key constraint to firm growth. Although active, the rental market is not capable of providing enough access to machines to all firms. Figure 11 reveals that almost 40% of firm owners in carpentry perceive access to machines as an important constraint to firm growth. Access to machines is perceived as much more important than access to skills. This is in line with the findings from Figure 7 about the determinants of profitability. Results for the other sectors are similar. Renters are more likely to report access to machines as their primary constraint in carpentry, and in 70% of cases, firms that are renting machines report that they are doing so as a second-best alternative, and would prefer to buy the machines if they could access enough liquidity to do that. Renters also have significantly lower profits per worker than firms who own machines. These findings suggest that while most firms are

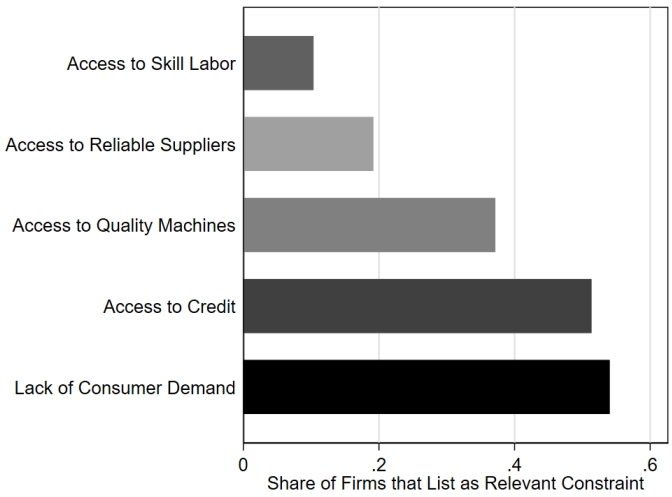
able to access the rental market, renters in particular still face significant challenges related to securing access to the machines they need, and so this is in line with potential inefficiencies in the rental market being substantial.

Figure 10: Role of Firm Networks



Notes: firm owners were asked whether they meet regularly with other geographically close firms in the same sector to either share production inputs or discuss about business practices. The first row reports the share of firm owners that answer "yes" to that question – i.e. that have a business network. We further ask to the firm owners what type of activity they do with other firms in their network. Rows 2-4 report the share of firm owners that report to have a network and to either borrow/lend machines within the network (row 2), share production workers when in need (row 3) or borrow/lend materials (row 4).

Figure 11: Constraints reported by firm owners



Notes: Firm owners were asked to name, among a predetermined list with 14 options, at most three relevant challenges that they face when thinking about increasing the profitability of the business. The Figure shows the share of firms that listed each challenge as relevant (the Figure reports only the top five most commonly reported challenges).

Taken together, our descriptive evidence shows that the rental market goes a long way in helping firms achieve **economies of scale** *collectively*, thus mitigating the productivity losses from small firm scale. However, the fact that despite the existence of the rental market there is a wide dispersion in the use of modern machines and firms report difficulties in accessing machines among their primary constraints suggests that the rental market might be inefficient. The key question then is how large are frictions in the rental market, and what would be the productivity gains from reducing such frictions through policy intervention.

To answer this question, we are building a model of firm behaviour that allows us to: (i) quantify to what extent firms are able to exploit economies of scale collectively thanks to the existing rental market, and (ii) run **policy counterfactuals**. For instance, we can compute counterfactual profits under the two extreme scenarios of: (i) shutting down the rental market completely, so that each firm either buys the machine or cannot use it in production; and (ii) consolidating firms together, thus bringing to zero the rental market frictions. We can then compare these scenarios to the productivity achieved in the status quo, which is informative of how efficient the rental market is at helping firms achieve scale.

In summary, the key **academic contributions** of our study are twofold: first, we collect novel data that allows us to quantify productivity differences across firms within the same sector, and study the determinants of such differences; second, our rich data allows us to document that economies of scale driven by the capital input are important in this context, and that small firms manage to achieve scale *collectively* by sharing resources in firm clusters through an active inter-firm rental market. We believe this result is novel and refines our understanding of the role of firm size in developing countries, and its implications for productivity. We expand on the academic contribution of our study in the working paper that we are currently writing as an additional output from this IGC project (see Bassi et al (2019)).

6. Conclusion, Policy Implications, and Next Steps

Our results so far carry two main policy implications.

1) First, while our analysis is not causal, our results do show that the main factor that differentiates productive and unproductive firms is mechanization. **Policies stimulating mechanization** are likely to be particularly promising in increasing productivity. What seems particularly important is to provide less productive firms with more opportunities to access the machines they need at lower costs, potentially by expanding **rental markets** and improving their functioning. There is a need for further impact evaluations in this area.

2) Second, our results suggest that it might be possible to leverage the cooperative nature of firm networks to increase mechanization and spur productivity within **firm clusters**. For instance, an intervention that provides machines to firm clusters and encourages firms to create a sharing agreement to use such machines could prove to be highly cost-effective.

In fact, the Ministry of Trade of Uganda, together with the Office of the President, has for some time been providing machines to clusters of firms around Uganda. The decision of the Ministry and the President to engage in this kind of intervention was a response to the demands of local

producers for help in accessing modern technology. Evaluating similar types of interventions and providing evidence-based recommendations to help enhance their effectiveness through a randomized control trial seems a promising way forward for industrial policy in Uganda and other developing countries.

We will be able to provide more precise policy recommendations once the model described above has been estimated and used to conduct counterfactual analysis. In particular, our model allows us to study the implications of the existence of the rental market for **policy effectiveness** and **optimal targeting**. Through our model, we will be able to answer questions that are of clear policy relevance, such as: if we want to increase the productivity of small firms, is it more effective to subsidise the small and unproductive firms to help them buy machines, or to target the larger and more productive firms to help them buy more machines that they can then also lend out to the less productive firms? Once we allow for the existence of a developed rental market the answer to this question is not obvious any more: in fact, the most productive firms might be those more able to sustain the new capital investment, while the benefits from the new capital might still trickle down to other less productive firms through the rental market, thus generating positive spillovers to the rest of the cluster.

More generally, within the model we will then be able to **simulate different type of interventions** and forecast their expected impact and cost-effectiveness. Our medium-term goal is then to implement and causally evaluate the interventions that our model and data suggest would be the most promising.

As we develop the model, we are also conducting a pilot study to assess the feasibility of two potential interventions that our descriptive evidence already suggests might be particularly effective at spurring productivity in firm clusters. The first intervention consists in encouraging firms in the same cluster to form **business associations** to further increase firm-to-firm interactions and cooperation. The rationale behind this intervention is that the business associations could facilitate coordination within the cluster, which could then lead to an improvement in the functioning of the rental market for machines as well as in other activities such as sharing of workers, getting together to buy inputs or smoothing demand shocks by reallocating demand to other firms in the same cluster. While our data shows that firms operating in the same sector and location already do interact and engage in some amount of coordination, we believe that this intervention could help them overcome coordination frictions that might limit effective cooperation within the cluster. In short, we envision that the business associations could stimulate the small firms to behave more like "one large firm" thus leading to improvements in the allocation of resources and overall productivity.

The second intervention is a **machine rentals intervention** to directly increase mechanization by making it easier for groups of firms to rent out large machinery. This intervention follows in spirit the initiative of the Ministry of Trade and Office of the President described above. As part of this intervention, we will offer leasing agreements to groups of firms, whereby the group can lease some of the most expensive machines in carpentry, and then pay back their cost through instalments. Once the cost (plus interest) of the machines has been repaid, ownership of the machines will be transferred to the cluster of firms that took out the lease.

We have secured funding from the Center for Effective Global Action (CEGA) to run a **pilot of these interventions in two sub-counties**. For the business associations intervention, we are partnering up with the Uganda Small Scale Industry Association (USSIA). For the machine rental interventions, we are forming a collaboration with Tugende Ltd. Our aim is to use the results from this pilot, together with the counterfactuals generated by the structural model, to identify promising interventions that could then be evaluated at scale through a larger grant. In fact, Tugende Ltd are using this pilot as a way of testing the economic viability of introducing a new financial product targeted to groups of manufacturing firms. Tugende have already expressed interest in rolling-out this new financial product across the country if the pilot reveals this to be a potentially profitable opportunity.

The preliminary results described in this report also suggest a number of interesting questions that we plan to explore in more detail with the survey data already collected. First, we will conduct additional analysis to explore why the already existing rental markets do not succeed in alleviating **constraints to machine access**. We will use data on reported market values and rental costs of each machine to better understand the cost of renting vs buying a machine. Since most firms report renting the machine from another firm in the cluster, we will also perform a cluster-level analysis to explore how rental costs for specific machines vary depending on how many firms in the cluster own the machine. This will be informative of whether rental costs are particularly high in some areas due to the scarcity of certain types of machines. Using GPS coordinates of each firm, we will also study whether reported challenges in accessing machines increase with the spatial distance from firms that own a machine (which they could potentially rent out). This will be informative of the role of transport costs in limiting the potential of the rental market to alleviate constraints to machine access.

Second, we will focus on understanding the **demand-side of the market**, and in particular why lack of demand is reported as one of the primary constraints to growth. We collected information on: (i) prices and price ranges for final products; (ii) access to output markets; (iii) marketing and advertising activities; (iv) competitive and cooperative behaviour with other producers in the cluster. We are supplementing this data with cluster-level data on total population and connectedness to major cities through road networks. We will study how these observable firm- and cluster-level characteristics correlate with perceived lack of demand. For instance, we will be able to uncover whether perceived lack of demand is lower among firms that are better connected to output markets, or among firms that face less intense competition for customers within the cluster. While these relationships will be correlational in nature, we see this as an important first step towards understanding why firms perceive lack of demand as being important.

In addition, we will use data on the involvement of family members in the firm activities, and on the aspirations and expectations of the firm owner, to study whether low productivity and high perceived lack of demand can in part be explained by some firms being family firms with low potential (and low aspirations) to grow. In doing this, we will contribute to the literature on **high-growth vs "last-resort" entrepreneurship** in developing countries (de Mel, McKenzie and Woodruff 2010, Fafchamps et al 2014, McKenzie 2017).

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