Self-employment within the firm *

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Abstract

This paper studies limits to within-firm labor specialization in low income countries and their impact on firm size and aggregate productivity. Using newly collected data on tasks allocation in the firm, we document low levels of specialization between firm owners and hired workers. We argue that this is in part due to the lack of standardization of manufacturing production, which makes it difficult to *unbundle* simple production tasks from more complex and skill-sensitive managerial ones. We develop an equilibrium framework that nests a within-firm assignment problem of labor to tasks in a dynamic occupational choice model. The ability of firm owners to flexibly allocate tasks within the firm depends on an *unbundling cost*, which modulates how difficult it is to separate managerial from production tasks. When this cost is high, the most skilled individuals cannot leverage their talent by specializing on managerial tasks, firms are small and have low productivity, and wages are low. Disciplining the model with our data, we find that the estimated unbundling cost substantially reduces average firm size and aggregate productivity. Moreover, it lowers the benefit of relaxing other barriers that limit firm growth: without labor specialization, the returns to scale are lower since firms are merely vehicles to share entry costs and production machines. Heterogeneity across sectors in our data corroborates the mechanism and interpretation of the model.

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1 Introduction

Purchasing a manufactured good can be a lengthy process in low-income countries. Instead of going to Ikea and choosing among a range of standardized sizes, materials, and colors, buying even a generic dining table in Uganda might entail several visits to a carpentry shop. A customer would typically come to the shop to make an order, discuss details such as the size and finishes of the product as well as the wood to be used, and negotiate price and delivery time. The quality of the final product depends on the craftsmanship of the carpenter as well as on successful communication and trust between carpenter and consumer. Along these dimensions, manufacturing in low-income countries resembles personalized services like hairdressing or consulting, in which the quality of the product also relies on the interaction between customer and provider. We refer to this feature of the market as the *personalization* of manufacturing production in low-income countries.

The premise of this paper is to point out an important implication of personalization: it restricts the capacity to *unbundle* production tasks, that is, to split the production process into multiple steps and delegate them to specialized individuals. In, say, the Ikea model, quality controls and standardization – enforced through brand reputation – render the identity of the person producing each item irrelevant. In contrast, in low-income countries, personal interaction between the customer and the individual in charge of the entire production process substitutes for product standardization and quality enforcement. As a result, delegating the communication with customers or other parts of the production process could lead to a decline in the actual or perceived output quality.[1]

Our main contribution is to argue that the larger cost to unbundle and delegate production tasks has important consequences for aggregate productivity in low-income countries: by limiting the scope for labor specialization within manufacturing firms, unbundling costs worsen the economy-wide allocation of talent and hinder firm growth.[2] To do so, we combine a newly collected survey of Ugandan manufacturing firms with an equilibrium model of within-firm task allocation, occupational choice, and firm dynamics. The data show that there is limited labor specialization within firms: Owners and workers allocate their time to similar tasks and are often in charge of the entire production process for an item. As such, they could be described as *self-employed within the firm*, merely sharing a premise and possibly a machine. The model

[1] Arguably, modernization of production often goes through a process of standardization and tasks unbundling, even in personalized services. One example are chains of hairdressers – e.g. Jean Louis David – which attempt to standardize hair cuts by letting customers choose only among a set of pre-defined ones. Nonetheless, the key insight is that, while some standardization and task unbundling is possible even in typically personalized interactions, these are costlier.

[2] Our analysis of course raises the question of why manufacturing production is personalized in low-income countries, hence of why it is costly to delegate tasks. While we take this feature of production as a primitive for the premise of this paper, we discuss a few potential explanations in the paper.

sheds light on how the inability to unbundle production tasks not only affects within-firm organization, but also has equilibrium effects that ripple through the economy: if unbundling costs are high, the manufacturing sector is made up of many small firms with low productivity and depressed wages. High unbundling costs also limit the impact of any intervention that may relax barriers to firm growth: the return to increasing firm size is lower if highly skilled individuals cannot leverage their talent by specializing on the most complex tasks.

We surveyed a representative sample of both workers and owners of Ugandan manufacturing firms in three sectors – carpentry, metal fabrication, and grain milling. These sectors capture 32% of total manufacturing employment and 27% of manufacturing employment in firms with five or more employee. They thus represent a relevant snapshot of the organization of production in both small and relatively large – by East African standards – firms. We build on our own previous work and start from the sample of firms we surveyed in Bassi, Muoio, Porzio, Sen, and Tugume (forthcoming), for which we have detailed data on firm and product characteristics. We implement additional rounds of surveys to complement this data with information on the organization of labor within the firm and on the nature of customer-producer interaction. Importantly, we collect several details on the production process, all tasks involved in production and sales, and on the time that each individual spends on them. This allows us to study the degree of labor specialization and understand what drives it and how it relates to the personalization of manufacturing.

As a first step, we describe the setting of the study, focusing on the personalization of manufacturing production and on how it plausibly limits the ability to unbundle and delegate production tasks. Most of the firms in our sample are well-established businesses. They have on average five employees, use relatively modern machines, and are licensed to produce. These firms, however, struggle to grow, mainly due to their limited ability to build a customer base, which owners name as their firm's main constraint. The difficulty to grow a customer base is inherently linked to the informal way in which firm demand is generated. There is no formal advertising and firm owners report that "talking to customers" is their typical marketing strategy. Unsurprisingly, most customers are local and are often known personally by either the firm owner or an employee. Two thirds of the sales are made to order, through walk-ins, suggesting a lack of standardization.

While these features are common across sectors, there are crucial distinctions. In carpentry and welding, sales are made to order because they are customized in term of dimensions of the product, inputs used, and finishes. Production takes several days and there is non-negligible uncertainty over the quality and delivery time of the final product. In line with this, we document substantial price dispersion even within narrowly defined products and geographical areas. In grain-milling on the other hand, the production process is faster and more standardized, and we document lower dispersion in price. Most orders simply entail milling grains to one of the

pre-specified levels of fineness. Production is also mainly made to order, but this is due to the fact that most people bring their own inputs, i.e. grain, to the mill. By bringing their own grain, customers solve the primary source of uncertainty in this sector: it is hard to distinguish whether grains are rotten. Overall, we conclude that production is highly *personalized* in carpentry and welding, but less so in grain milling.

We then provide three sets of facts on labor specialization within firms, and on occupational choice – i.e. on the allocation of talent within and between firms. We start by presenting the facts for carpentry and welding, and then contrast them with grain milling.

First, there is limited specialization of labor within the firm. To summarize labor specialization, we use our detailed data to classify tasks into simple production tasks, or more complex and skill-intensive managerial ones – such as interacting with customers or procuring inputs –, and measure the share of time that each individual spends on each set. We find that firm owners spend a large share of their time on simple production activities, almost as much as employees do. On the flip side, employees spend a considerable share of their time on managerial tasks. That is, we document that employees largely resemble firm owners in terms of their time allocation and so effectively behave as self-employed within the firm. In line with this, it is common for employees to take on independent orders where they manage production as well as the entire relationship with the customers as if they were self-employed.

Second, labor specialization is limited in firms of all sizes. The time allocation of workers between production and managerial tasks as well as their specific responsibilities within the firm are almost identical across the size distribution. Firms owners do spend less time on production and more on managerial tasks in larger firms, but these differences are small: in firms with one employee, owners spend 60% of their time on production tasks, while in firms with 20 employees, that fraction goes down to 50%.

Third, talent allocation between occupation is driven mainly by age, rather than other fixed characteristics such as schooling: Owners are older than workers, but otherwise fairly similar. The typical successful individual climbs an occupational ladder: she starts as a worker, accumulates knowledge and capital, and then, facing limited career opportunities within the firm, starts her own firm. Among the firm owners we surveyed, 60% were previously working as employees in the same sector.

These three facts mainly apply to carpentry and welding. In grain milling, there is stronger labor specialization, especially in large firms. Workers are on average less skilled and only rarely end up starting their own firm. Overall, the cross-sectoral heterogeneity corroborates our interpretation of personalization of production being a key driver of talent allocation: in the sector with less personalized production, we observe a higher degree of specialization.

We then build and estimate a general equilibrium model to formalize and quantify how obstacles to task unbundling impact the allocation of talent within and across firms and, conse-

quently, aggregate productivity. The key building block of the model is the production process. Production of each unit of output requires completing a set of tasks, which differ in their level of complexity. If self-employed, each individual must complete all tasks herself. Within a firm, instead, individuals can delegate some tasks to others. Firm productivity is a weighted average of the ability of all individuals producing, weighted using the share of time each one spends on the complex tasks. Delegating complex tasks to more skilled individuals can therefore increase firm productivity. However, unbundling comes at a cost that is modulated by a key parameter capturing – in reduced form – the notion of personalization of production. If production is personalized, it is more costly to unbundle production tasks and the cost is higher. The firm owner decides who completes each task, trading off the cost of unbundling against the productivity gains from labor specialization.

We embed this theory of within-firm organization into an otherwise fairly standard model of occupational choice over the life-cycle. Given a current level of ability and cost of capital, individuals choose whether to be workers in an outside sector or to enter the manufacturing sector. If they enter the manufacturing sector, they can either work for an existing firm or start their own, subject to an entry cost. Firm owners choose how many workers to hire (randomly matched from the endogenous distribution), subject to an auxiliary "cost of size" that is a stand-in for working capital as well as any other frictions that might keep firms small.[3] Individual ability evolves endogenously as a function of occupation and task assignment within the firm: the more complex tasks an individual performs, the more she accumulates talent. In addition, workers can learn from the owner of the firm they work at. In equilibrium, the (average) wage in manufacturing adjusts to clear the market.

We use the model to characterize theoretically how the unbundling cost affects the allocation of talent within and between firms, ultimately determining the firm size distribution and aggregate productivity. The unbundling cost transforms how firms are internally organized. If the cost is prohibitively high, each worker is essentially self-employed within the firm, that is, she performs tasks of all levels of complexity herself. Firm productivity is simply the average ability of workers and firm owner. In this case, firms are merely means of sharing the entry cost, and the size distribution is pinned down by the auxiliary size cost. When the cost is zero, instead, our model collapses to a standard Lucas (1978) model: labor is fully specialized and firm productivity inherits the ability of the owner, which, in equilibrium, is the most skilled individual of each firm. Firms are now a vehicle to allow the most talented individuals within the economy to leverage their talent. More generally, as we vary the cost of unbundling, the within-firm organization changes, and with it, the fundamental notion of what a firm is. The unbundling cost affects the whole economy, not only the within-firm organization: we prove

[3]Allowing for this flexible "cost of size" avoids erroneously attributing the small observed firm size purely to delegation costs.

that an economy with a lower unbundling cost has higher aggregate productivity, larger firms, and higher wages.

The model also highlights the tight and two-way link between the size of a firm and the degree of labor specialization. On the one hand, in small firms, there is little scope for specialization: even if the most skilled individuals took on all complex tasks, she would have time left over for production. On the other hand, the less scope there is for labor specialization, the lower are the returns to growing one's firm. If it is very costly to unbundle tasks, even highly skilled individuals cannot take over many complex tasks from their employees, which reduces the benefits of running a large firm. Therefore, theoretically, it could be that firms in low income countries are either small because unbundling tasks and labor specialization are costly, or they can have limited labor specialization because they are small. Ultimately, to resolve this question, and more broadly to quantify the impact of the personalization of manufacturing production on the economy, we need to use our data and model together.

To discipline the model, we use data for carpentry and welding. We instead use grain-milling to provide some model validation. The model matches both qualitatively and quantitatively the three key facts on the allocation of talent, and is consistent with several empirical moments on the distribution of firm sizes and revenues, and on individual life-cycles. Our unique data on labor specialization within the firm allows us to estimate directly the unbundling cost. Given this cost, and the observed distribution of firm profits, productivity, and worker wages – which help to discipline the heterogeneity in managerial ability and the returns to scaling up the firm – we can then recover the "cost of size" to match the observed distribution of firm sizes.

With the estimated model, we quantify the two-way relationship between labor specialization and firm size, and how it determines aggregate productivity. We perform two simple exercises: (i) varying the unbundling cost from 0 to ∞, and (ii) decreasing the "cost of size" to match the average firm size in the United States in these same sectors today. Decreasing either cost leads to increases in labor specialization, firm size, and aggregate productivity. However, while the first exercise generates large increases in all three variables, the second exercise leads to a large increase in firm size (from 5 to 28 employees on average), but only to a relatively small increase in specialization and productivity. We conclude that, while it is both true that firms are small because they are not specialized and that they are not specialized because they are small, the former causal relationship appears to be quantitatively stronger.

The relative strength of the two relationships is driven by some key empirical moments. For the first one, the key is that we estimate a large heterogeneity in managerial ability. Given this, an increase in specialization leads to a large effect on firm-level productivity (firm owners are much more skilled than the workers), and consequently on firm size. For the second one, the key is to notice that in our data, even in relative large firms, we observe that the owners spend almost half of their time in production tasks. This result implies that, given the unbundling

cost that is needed to match the data, even a very large increase in firm size would not be enough to generate big changes in labor specialization, nor in firm productivity. Firms still expand as other frictions constraining the firm size are reduced, but effectively do so by adding workers who largely behave as self-employed, with resulting small increases in specialization and productivity.

These results have important policy implications since they highlight that relaxing barriers to firm growth – such as credit or hiring constraints, which would be captured in reduced form by the "cost of size" – may have only a limited effect in the presence of large unbundling costs.[4] If firm owners cannot leverage their talent by specializing on the more skill-intensive managerial tasks, then the returns to scale are, endogenously, lower. In the absence of labor specialization, firms are mere vehicles to share entry costs, and increasing their size has a muted aggregate effect. To highlight this point, we show that the aggregate effects of decreasing the "cost of size" are much larger if we reduce the baseline estimate for the unbundling cost.

Finally, we turn to the heterogeneity across sectors to validate our model. Starting from the baseline model estimated to match labor specialization in carpentry and welding, we reduce the unbundling cost to match the larger amount of specialization documented in grain milling. Doing so not only leads to an increase in average firm size that roughly matches the observed differences across sectors, but also matches the differences in the individual life-cycles and occupational choices across sectors (Fact 3). Instead, neither decreasing the "cost of size" to match the average firm size in grain milling, nor changing the cost of entry can explain the observed differences across sectors in labor specialization. This result corroborates the prominent role of unbundling costs driven by the personalization of production in explaining differences in the organization of production, both across countries, and within countries across sectors.

Related literature. Our main contribution is to quantify the extent to which the personalization of manufacturing production in low-income countries limits labor specialization, productivity, firm size and wages. In doing so, we contribute to an established literature on the determinants of why firm productivity is lower in developing countries and the size distribution is dominated by many small firms (Bloom et al. (2010); Hsieh and Olken (2014)). This literature has focused on the role of management (Bloom et al. (2013)) and limits to delegation (Akcigit et al. (2021)), emphasizing that the low adoption of managerial practices and frictions in the external labor market for managers impede firm expansion and productivity growth. Our contribution is to highlight how the personalization of production reduces the extent to which firm owners can leverage the managerial talent they possess and are able to delegate tasks to

[4]For instance, De Mel et al. (2019)) find that providing wage subsidies to small firms in Sri Lanka increases firm size without increasing firm productivity.

the workers they already employ.

A related literature studies the role of frictions in the output market as a barrier to growth (Bold et al. (2022); Jensen and Miller (2018); Hjort et al. (2020); Startz (2019)). We contribute by showing how a specific feature of the output market – the characteristics of the products that are made by firms – impacts firm productivity by affecting the internal allocation of labor.[5]

Finally, we contribute to a classic theoretical literature in organizational economics, which has long emphasized the importance of specialization of labor within the firm for productivity and growth (Chandler (1970); Becker and Murphy (1992); Bolton and Dewatripont (1994); Yang and Borland (1991)). More recently, this literature has focused on understanding the role of hierachies for firm growth, both theoretically and empirically (Garicano and Rossi-Hansberg (2006); Caliendo et al. (2015)). We contribute by providing novel micro-data on task allocation between owners and employees within developing country firms, which allows us to directly measure specialization at a granular level, without the need to make assumptions on the tasks carried out by different individuals based on their job titles, which indeed we show would have led to misleading conclusions about the extent of specialization in our context.

2 The Survey

This section describes the survey we conducted in Uganda to study labor specialization inside the firm. The survey includes two waves: an initial round of data collected in 2018-19 and a follow-up survey conducted in the spring of 2022. The initial survey is described in detail in Bassi et al. (forthcoming). Here we briefly summarize the key elements of the sampling strategy and survey design and then focus on those sections of the survey instrument where we measure labor specialization inside the firm and that do not feature in our previous work. We then describe the follow-up survey, which was designed specifically for this paper.

2.1 Sampling

Our survey targeted firms in carpentry, metal fabrication and grain milling. We chose these sectors because: (i) they are large, employing about 30% of workers in manufacturing; and (ii) they include both smaller and – for Ugandan standards – larger firms, which allows us to study labor specialization across the size distribution.[6]

[5] Holmes and Stevens (2014) show that in the US firms producing customized products tend to be small as they serve a small share of the market. We contribute by linking product customization to the internal organization of the firm and aggregate outcomes.

[6] The latest Census of Business Establishments from the Uganda Bureau of Statistics from 2010 shows that these three sectors comprise 32% of total manufacturing employment and 27% of manufacturing employment in firms with 5 or more employees.

We selected a representative sample of 52 sub-counties for the survey, stratifying by total population and whether the sub-county is in the broader area of Kampala, the capital city.[7] Within each sub-county, we first conducted a complete firm listing in these sectors, identifying close to 3,000 firms. We then randomly sampled about 1,000 firms from the listing, oversampling firms employing more than five workers to ensure enough observations among relatively larger firms. We interviewed the owner and all employees working on pre-specified core products that are common in the three sectors: doors in carpentry, windows in metal fabrication, and maize flour in grain milling.[8] Our final sample includes the 1,115 owners and 2,883 employees who answered the initial survey.[9]

2.2 Initial survey

The initial survey was conducted through in-person visits at the firms in 2018-19. The aim of the initial survey was to collect detailed information on *how* firms produce and on the economic environment in which they operate. Specifically, we asked detailed questions on: (i) the entire production process for the core products; (ii) demographics of owners and employees; (iii) output market characteristics; (iv) labor specialization inside the firm.

Starting from the measurement of the production process, we collected information on the hours of machine and labor time used in each production step, as well as on the characteristics of the machines and workers involved in each step. Moving to the details of owners and employees, we have information on age, years of education, tenure, as well as a range of measures of individual ability, including a standardized index of managerial ability for firm owners (based on multiple survey questions (McKenzie and Woodruff, 2017) and measures of cognitive and non-cognitive skills for workers. On output market characteristics, we collected information on how firms find customers and on perceptions about constraints to growth, as well as on prices of the core product. Finally, to measure labor specialization inside the firm, we used time diaries of owners and employees, as described in more detail in the next paragraph.[10]

Measuring labor specialization To measure labor specialization, we asked the owner and every employee to indicate all the hours in which they worked in a typical day in the last week. For each hour, we then asked to indicate the specific tasks they performed, choosing

[7] A sub-county is the second largest sub-national administrative unit in Uganda. The average sub-county consists of 5,285 households and spans 4.4 square miles.

[8] If a firm did not produce the pre-specified core product, we interviewed all employees working on the main product of the firm, as discussed in more detail in Bassi, Muoio, Porzio, Sen, and Tugume (forthcoming).

[9] Compliance with the initial survey was high at over 90% and all our results are appropriately weighted to reflect our sampling strategy.

[10] Bassi, Muoio, Porzio, Sen, and Tugume (forthcoming) primarily use the data on the production process to study the rental market for machines in carpentry. The data on labor specialization is not used in this previous paper and instead constitutes the key measurement innovation that we leverage in this paper.

from a pre-specified list of 16 possible tasks (plus an option to specify other tasks not on the list). The list included tasks related to physical production (e.g. working on the main product of the firm) but also non-production tasks encompassing all activities that typically need to be carried out to run a business, such as managing customer interactions, book-keeping and financial management, sourcing of inputs, maintenance of machines, management of stock, or supervision and training. Finally, we know the amount of time that workers and owners spend being inactive, that is, away from the firm for non-business reasons or eating/resting. This unique data allows us to construct the share of time owners and employees spend on different tasks, which is the key input for our measure of labor specialization inside the firm.

In addition to time allocation across production and non-production tasks, we also collected information on the share of production time that owners and employees spend on the various production steps for the core product. We leverage this data to study labor specialization within production at a granular level.

2.3 Follow-up survey

In the spring of 2022, we conducted a follow-up survey on all owners and employees for whom we had phone contact information from the initial survey. In total across the three sectors, we had phone numbers of 1,101 owners (out of the 1,115 interviewed in the initial survey) and 2,177 employees (out of the initial 2,883). The main aim of the follow-up survey was to collect information on owner and employee labor market histories since the initial survey and to gather additional details on labor specialization inside the firm.

On dynamics, we collected information on the labor market histories of owners and employees since the initial survey. For owners, we asked if they still run the same firm, and if not, their labor market status at the time of the survey. We also asked additional retrospective questions on their labor market history before starting the firm, such as their previous occupations, the reasons why they started their firm at the time they did, as well as a detailed accounting of the start-up costs incurred when initially setting up the firm and how they financed those. For employees, we asked if they are still employed at the firm, and if not, the reason for leaving and their current occupation. We also ask detailed information on how wages are set inside the firm as well as changes in wages and positions of employees within the original firm since the initial survey.

On labor specialization inside the firm, we collected additional information on interactions with customers, to shed light on how product customization may lead to production activities and non-production activities such as customer management activities being "bundled" together. For instance, we asked whether employees effectively perform "independent orders" at the firm, that is, whether they take on orders that are conducted at the firm's premises but are managed

entirely by the employee who is the residual claimant on the profits from the order.

Attrition from the follow-up survey is described in Appendix A.1. In short, we successfully managed to trace and interview about 68% of owners and 59% of employees. Attrition is higher in the grain milling sector, but not differentially so by firm size and managerial ability, which are two key variables of interest in the empirical analysis of the next section.[11]

3 The Organization of Production Inside the Firm

In this section, we use our survey data to study labor specialization inside the firm. We start by presenting descriptive statistics on characteristics of firms, output markets and products, in order to describe the context in which these firms operate, and to highlight the relevance of the personalization of production, focusing on differences across sectors. Then, we present three key facts on labor specialization that emerge from our survey data and inform our model.

3.1 Descriptives on firm, output market and product characteristics

Table 1 reports descriptives from our data. Panel A shows that the firms in our sample are well-established entities: the large majority of them are registered with the local authority and the average firm generates around $1,200-$1,900 in revenues per month. Panel A also shows that firms tend to produce similar products within each sector: about 70%-90% of the firms across sectors make the core product that we asked about. The average firm uses about 20% of the pre-specified modern machines listed in our survey, showing that the production process of the average firm is at least partly mechanized. Finally, Panel A shows that grain milling firms are larger than carpenters and metal fabricators, employing on average 6 relative to 4.5 workers. We will come back to this result in the model section where we show that our model is able to explain this gap in size.

[11] Uganda was subject to two strict Covid-19 related lock-downs, the first in April-May 2020 and the second in July 2021. Our follow-up survey was collected in spring 2022, and so well after the Covid-19 related restrictions were lifted. Our follow-up survey asked about firm closures around the time of the second lockdown, and the data shows that while 46.3% of firms were either closed or only partially open during the lockdown, 88.5% were fully operational quickly after, so concerns about firms exiting from our panel due to the Covid-19 shock are not first order. In a separate survey of the same sample of firms conducted after the first lockdown (and not used for this paper), Bassi, Porzio, Sen, and Tugume (2021) find a similar pattern of a sharp but largely transitory increase in firm closures during the first lockdown.

Table 1: Descriptives on firm, output market and product characteristics

	Carpentry	Metal fabrication	Grain milling
Number of firms	522	433	160
Panel A. Firm characteristics			
Monthly revenues (USD)	1,222	1,548	1,916
Number of employees	4.5	4.9	6.0
Machine utilization rate (%)	23%	17%	19%
Share with trading licence (%)	76%	86%	91%
Share making core product	68%	92%	93%
Panel B. Output market			
Share saying that demand is a crucial constraint	54%	54%	57%
Owner spends money on marketing	7.7%	12.0%	7.8%
Talks to customers to communicate product quality	56%	52%	47%
Share of sales made to order	70%	74%	67%
Share of sales done through walks-ins	76%	78%	94%
Share of customers known before transaction	43%	44%	43%
Panel C. Product characteristics and customization			
Minimal time needed to produce main product (mins.)	433	351	56
Median number of days taken to complete typical order	4.0	4.0	0.6
Customer stays at premises while order is made	25%	33%	87%
80-20 residual price dispersion for main product (Std.)	1.46	1.61	1.15
Share of firms using customers' inputs	18%	14%	78%
Share of workers performing independent orders	25.1%	28.6%	9.9%

Notes: Panel A shows firm characteristics. The machine utilization rate is defined as the share of the pre-specified machines that the firm uses in production. The list of possible machines was sector-specific. The core products are doors in carpentry, windows in metal fabrication and maize flour in grain milling. Conversion rate for monetary amounts: 1 USD = 3,800 UGX. Data is from the initial survey. Panel B shows descriptives on the output market. Panel C shows product characteristics. Data is from the initial survey. The price dispersion is after removing sub-county fixed effects. Data on minimal time to complete the order and residual price dispersion is from the initial survey. The other rows of Panel C use data from the follow-up survey.

Panel B uses our detailed survey data on the output market to show that firms struggle to grow their customer base and establish a wider brand reputation through marketing. The majority of firms cite lack of demand as a critical constraint to growth, only 8-12% of firms spend any money on advertising. As a result, they operate in an informal and highly local product market where personal interactions with customers are key: 47-56% of firms report that directly talking to customers is their main strategy to signal product quality. In line with this, most sales are made through walk-ins, often by customers previously known to the firm. Importantly, most sales are made to order, rather than the customer buying a ready-made

product. Panel B shows a remarkable similarity of these features of the output market across sectors.[12]

However, Panel C shows significant heterogeneity across sectors in the characteristics of the products that are sold. In carpentry and metal fabrication, products are customized to the specific needs and tastes of the customer: the production process for a door or a window takes about 6-7 hours of continuous work and the typical order in carpentry and metal fabrication takes multiple days to complete. In line with this, most customers do not stay at the firm premises while the orders are being produced. The high degree of personalization results in high dispersion in price for the same product even within the same sub-county. From the perspective of the customer, output quality in these sectors is therefore highly uncertain because: (i) it requires agreeing not only on price but also on various product specifics including design and materials, which may be subject to misunderstandings; and (ii) the quality of the production process is difficult to verify until the product is ready because it takes long to produce.

In grain milling instead, the production process is much more standardized: producing one kilogram of maize flour takes less than an hour, and the typical order is completed on the same day, so that the majority of customers remain at the firm's premises while the order is being prepared. In line with output being more standardized, residual price dispersion in grain milling is also lower. Product quality in grain milling is therefore much less uncertain from the point of view of the customer because production happens quickly and it does not involve choosing a specific design or specific product features. One potential source of uncertainty in grain milling is the quality of inputs, the grain itself. This is solved by customers largely bringing their own maize to be milled, as shown at the bottom of Panel C.

In short, the degree of product personalization and uncertainty in product quality are both much higher in carpentry and metal fabrication than in grain milling. One way to limit such uncertainty in carpentry and metal fabrication may be for the customer to be directly involved in discussing product specifics and design with the employee producing the order, rather than a specialized salesperson. Indeed, in Appendix Figure A.2, we report the breakdown of answers to a survey question on why customers buy from the firm on order rather than purchasing a ready-made product. The main reasons for buying on order in carpentry and metal fabrication are that: (i) customers want to choose their own inputs, (ii) customers want special product features, and (iii) they want to be able to discuss the details of the product with the person in-charge of production. Instead, in grain milling the predominant reason for buying on order is that customers bring their own inputs. Moreover, 25-29% of firm owners in carpentry and metal fabrication report that their employees perform independent orders, whereby the employee fully

[12]Related work by Bassi, Kahn, Lozano Gracia, Porzio, and Sorin (2022) studies how reliance on face-to-face interactions with customers affects firm location choices within Ugandan cities, exposing them to high levels of air pollution.

manages the relationship with the customer and also produces the product. This share is instead only 9.9% in grain milling (Panel C, Table 1).

In the rest of the paper, we leverage the comparison between carpentry and metal fabrication on the one hand with grain milling on the other, to study how product characteristics and the personalization of production determine labor specialization inside the firm and aggregate outcomes.

3.2 Labor Specialization and Career Dynamics

We present three key facts on labor specialization and career dynamics that emerge from our survey data. Given the similarities between carpentry and metal fabrication identified in the previous section, we pool these two sectors together in this section, and contrast the results with grain milling. We notice that these three key facts look both qualitatively and quantitatively identical if we look at carpentry and metal fabrication separately (see the Appendix), but pooling the data facilitates a visual comparison with grain milling.

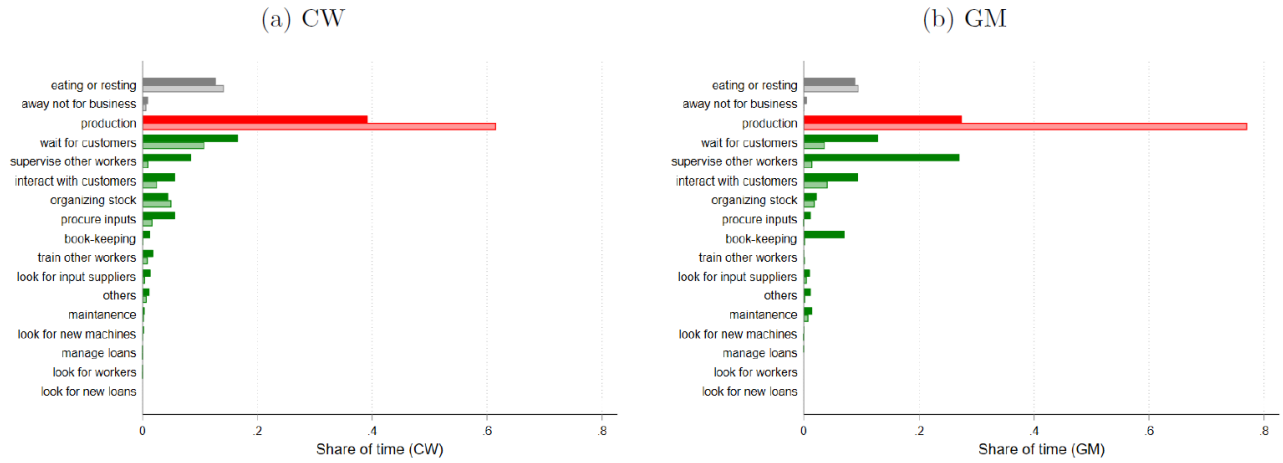
Fact 1: Limited specialization between owners and employees We use our data on time allocation across tasks described in the previous section to study labor specialization within the firm. For each owner and employee, we compute the share of time spent on each task. Figure 1 reports these shares for owners (darker bars) and employees (lighter bars), separately for carpentry and metal fabrication (Panel (a)) and grain milling (Panel (b)).

Conceptually, the 16 tasks can be divided into three separate groups that we label with different colors: (i) inactive time, which includes being away from the business for non-business reasons or resting/eating (grey bars); (ii) working on production of either the core product or another product made by the firm (red bars); (iii) non-production tasks encompassing all other tasks needed to run a business (green bars).

Figure 1 shows that specialization between owners and employees is limited. Focusing first on carpentry and metal fabrication in Panel (a), we see that while owners do tend to spend a little more of their time in non-production tasks, the differences between owners and employees are small: Owners still spend about 40% of their time in production tasks, and employees spend over 20% of their time in non-production tasks. That is, employees behave not that differently from firm owners in how they spend their time within the firm. This arrangement resembles what self-employed individuals would do in terms of their time allocation. Panel (b) instead looks at grain milling, and shows that even though labor specialization is limited in this sector as well, the difference in the time allocation of owners and employees is larger, with employees spending around 10% of their time in non-production tasks.[13]

[13]In Appendix Table A.1 we verify that being involved in non-production tasks is associated with an increase

Figure 1: Time use across tasks by owners and employees



Notes: Figure 1 shows the share of owner (dark bars) and employee (light bars) time spent in different tasks. We divide tasks into inactive time (grey bars), production (red bars) and non-production activities (green bars). If a respondent indicated more than one task per time slot, the time slot is split equally across the tasks performed. In Panel (a) the sample includes Carpentry and Metal Fabrication. In Panel (b) it includes Grain Milling. Data is from the initial survey.

In Appendix Figure A.1 we look at specialization *within* production tasks, by plotting the share of production time spent by employees and owners on each of the production steps for the core product. Production steps are ranked by difficulty, which we are able to do because we asked each employee and firm owners about their level of practical skills on each production step. The Figure confirms that: (i) the degree of specialization between owners and employees is also limited within production tasks, as firm owners spend time on most production steps; (ii) firm owners spend a larger share of their time on more complex production steps, and (iii) specialization is more pronounced within grain milling. [14] These results are in line with Figure 1.

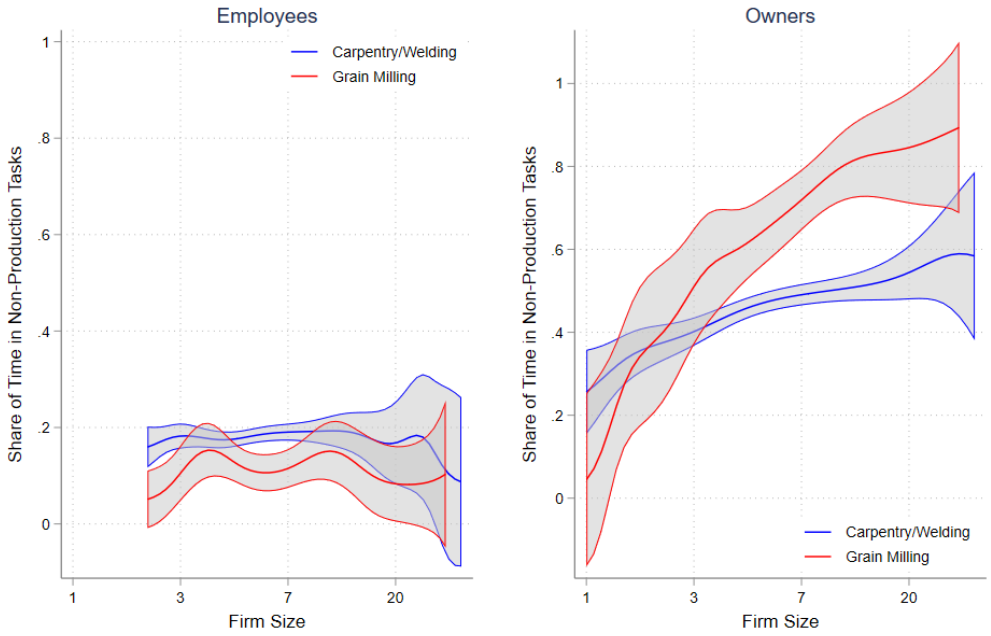
The differences across sectors we document in the degree of specialization between owners and employees are consistent with the differences in product characteristics discussed in the previous section, and with the cost of "unbundling" tasks being higher in carpentry and metal fabrication. In line with this, Panel C of Table 1 shows that the incidence of independent orders – where employees behave as self-employed by being fully in charge of both producing the order and managing customer relationships – is higher in carpentry and metal fabrication.

in salary for workers. This is consistent with non-production tasks being more complex tasks.

[14]The fact that firm owners do not only work on the most complex steps rules out that the reason why they are involved in production is because employees do not have the skills to carry out some steps in the production process.

Fact 2: Weak relationship between labor specialization and firm size We now turn to how the degree of labor specialization varies with the size of the firm. In modern manufacturing, we would expect a steep positive relationship between firm size and specialization: as the firm size increases, the firm owner there are simply more complex tasks for the owner to take on, allowing her to better exploit her comparative advantage within the firm.

Figure 2: Labor specialization across the size distribution



Notes: Figure 2 shows how the share of time spent in non-production tasks varies across the size distribution. The left panel uses the employee sample; the right panel uses the firm owner sample. We report the results of non-parametric regressions. The red lines correspond to the estimates for grain milling; the blue lines to the estimates for carpentry and metal fabrication. Data is from the initial surveys.

Figure 2 reports the results of non-parametric regression of the share of time spent in non-production tasks on firm size, measured by number of workers. The panels on the left and the right report the results for employees and owners, respectively. Starting from the left, we see that the time allocation of workers between production and non-production tasks does not vary at all with firm size: even in large firms, employees spend on average 20% of their time in non-production tasks. The Figure also confirms again that employee specialization is stronger in grain milling, where they spend less time on managerial tasks.

The right panel instead shows that in carpentry and metal fabrication, firm owners do spend more of their time in non-production tasks as the firm size grows, but these differences are small: in firms with one employee, owners spend 60% of their time on production tasks,

while in firms with 20 employees, this fraction goes down to 50%. On the other hand, the relationship between firm size and firm owner specialization is much stronger in grain milling: in firms with one employee, owners in grain milling spend about 70% of their time in production tasks, which goes down to as little as 10% in firms with 20 employees. Taken together, the results in Figure 2 uncover a strikingly limited role of firm size in increasing specialization in carpentry and metal fabrication, while the role of firm size is much more pronounced in grain milling.

Fact 3: Owners used to be workers We have so far focused on the allocation of talent within firms. However, we may expect that the internal allocation of labor to tasks within firms also affects the allocation of talent *across firms*, especially in a setting like ours in which many firms operate side by side in informal clusters. Our next fact characterizes this across firm allocation and how it varies across sectors.

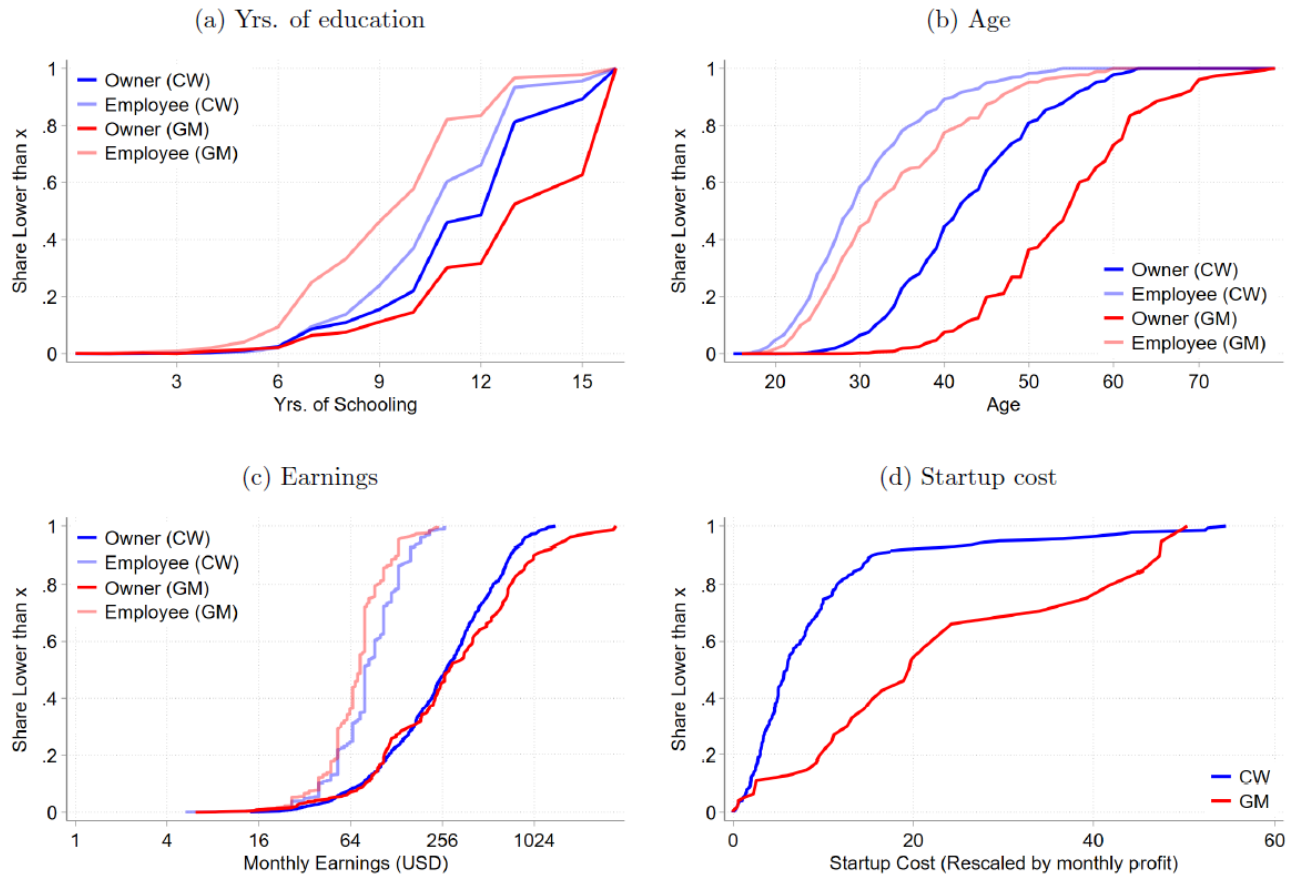
We use baseline survey data on the characteristics of owners and employees as well as information on employment histories from the follow-up round to study how owners and employees differ, and to characterize the typical career path of firm owners. We first present the results for carpentry and metal fabrication, and then highlight differences with grain milling.

Figure 3 compares the distributions of several characteristics of owners and employees. Starting from carpentry and metal fabrication, we find that the allocation of individuals across occupations is mainly driven by age rather than other fixed characteristics such as education: Panel (a) shows that firm owners are older than employees, while Panel (b) shows that they have very similar levels of education. Being an owner differs along one important dimension: as shown in Panel (c), firm owners earn much more than employees. This shows that there are large returns to starting a firm.

The typical employment histories of owners in carpentry and metal fabrication reveal a clear occupational ladder in these sectors: the left Panel of Figure 4 shows that 60% of firm owners used to be employees in the same sector in their last occupation before starting the firm. That is, most firms were generated through employee spin-offs from other carpentry/metal fabrication firms.[15]

[15]Figure 4 shows that only about 10% of firm owners in carpentry/metal fabrication started the firm from an apprenticeship position. This confirms that most firms are created through actual spin-offs rather than being a byproduct of apprenticeship systems where trainees have to leave the firm at the end of the apprenticeship period. The apprenticeship system is more prevalent in the West African context. For instance, Hardy and McCasland (forthcoming) study apprenticeships in Ghana.

Figure 3: Comparison of owners and employees, and start-up costs

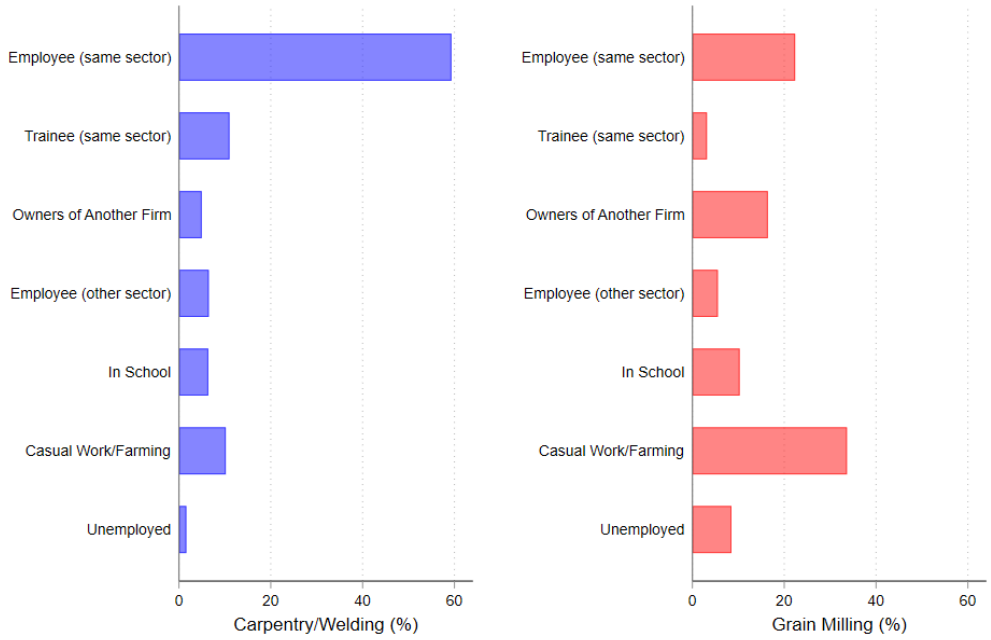


Notes: Panel (a) shows the CDF of years of education for owners and employees, by carpentry/metal fabrication (blue line) and grain milling (red line) separately. Panel (b) shows the CDFs of age. Panel (c) shows the CDFs of earnings, where earnings are monthly earnings from work at the firm for workers, and firm profits for owners. Finally, Panel (d) reports the total start-up costs incurred in the first month of activity of the firm, normalized by firm profits in the first month of operation of the firm. Data is from the initial surveys for all panels apart from Panel (d) where it is from the follow-up survey.

In order to become owners, employees need to cover a start-up cost. We collected detailed data on the start-up cost that the owner incurred to set up the firm. To do so, we asked specifically about all out-of-pocket costs that needed to be paid in the first month of firm operations.[16] Panel (d) of Figure 3 shows that in carpentry and metal fabrication, the median fixed cost is around 5 times the value of monthly profits in the first month.

[16]For instance, if a firm owner bought machines on credit, we record as part of the start-up cost only the down-payment they had to provide at the time of purchase, before beginning operations. We use a similar accounting methodology to compute all other fixed costs incurred by the firm in the first month of production, such as rentals of the premises.

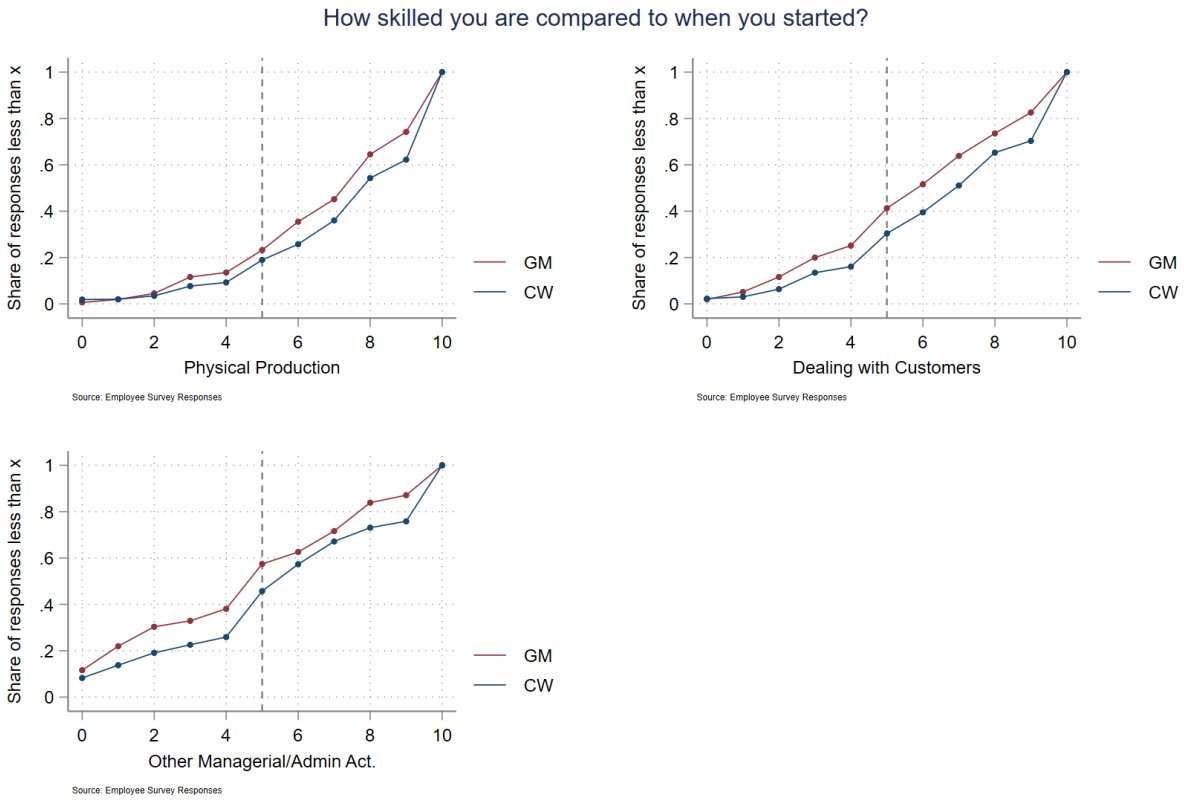
Figure 4: Previous occupation of current firm owners



Notes: Figure 4 shows the self-reported occupations of firm owners in carpentry and metal fabrication (left panel) and grain milling (right panel) immediately prior to starting their current businesses. The vertical axis shows various employment categories, e.g. an employee or trainee (apprentice) in the same sector, owners of another firm, or casual work/farming. Data is from the follow-up survey of firm owners.

While working at the firm, employees learn skills in addition to accumulating capital. In the follow-up survey, we asked employees to compare their current skill level to when they started in three dimensions: (i) physical production; (ii) dealing with customers and (iii) other managerial activities. The question was asked using a 0-10 scale where 0 is much less skilled, 5 is approximately as skilled, and 10 is much more skilled than when they started. Figure 5 shows the distributions. Focusing first on carpentry and metal fabrication, the majority of workers report having accumulated skills since they joined, especially on physical production and dealing with customers. In line with skills being something that workers accumulate on the job and then take on with them as they become firm owners, Appendix Figure A.3 shows that practical skills and reputation are the two main characteristics that employees perceive themselves as being worse at than firm owners. Finally, when asked why they did not start the firm a year earlier, firm owners in carpentry and metal fabrication report the lack of assets/savings (40.6%) most frequently, followed by lack of practical skills (18.9%). This again highlights the important role of both skills and capital in the decision to start a firm.

Figure 5: Employee's perceptions on skill accumulation



Notes: Figure 5 shows the CDF of self-reported skills accumulation for employees in carpentry and metal fabrication (blue line) and grain milling (red line). Employees were asked to report how skilled they are compared to when they started at the firm in three dimensions: physical production (top-left), dealing with customers (top-right) and other managerial or administrative tasks (bottom left). Measurement scale:0=much less skilled; 5=approximately as skilled; 10=much more skilled. Data is from the follow-up survey of employees.

On all these dimensions of career dynamics, there are striking differences across sectors: Figure 3 shows that owners in grain milling are much more educated than employees, and the age and earnings differentials between owners and employees are also much larger. In line with there being more a difference between employees and owners in grain milling, Figure 4 shows that a much lower share of firm owners in grain milling were employees in the same sector before. The incidence of employee spin-offs in generating grain milling firms is lower; firm owners primarily used to be engaged in farming before starting the firm. We validate this using our panel data to look at employee spin-offs within our sample between the two rounds of surveys: in the follow-up survey, we asked to each employee: (i) whether they are still employed at the original firm; (ii) their current occupation if they left, including also a specific question on whether they had set up a firm in the same sector. Table 2 reports the results of regressions at the employee level. In column 1, the dependent variable is whether the employee left the firm between the two survey waves. In columns 2-6 it is a dummy for whether the employee started

their own firm in the same sector. We regress these on a dummy for being in the carpentry or metal fabrication sector (so that the excluded category is grain milling) as well as a host of firm and worker level controls. The results show that while employees in carpentry/metal fabrication are not more likely to leave overall, they are significantly more likely to leave to set up their own firm.

Table 2: Correlates of employee spin-offs

VARIABLES	(1) left firm	(2) own firm	(3) own firm	(4) own firm	(5) own firm	(6) own firm
CW	-0.034	0.101***	0.107***	0.104***	0.110***	
	(0.052)	(0.021)	(0.023)	(0.022)	(0.022)	
Manager Ability (Std)	0.019	0.014		0.019*	0.023**	
	(0.017)	(0.012)		(0.011)	(0.011)	
Years of Schooling				-0.004	-0.004	-0.001
				(0.003)	(0.003)	(0.006)
Age				0.012**	0.010**	0.004
				(0.005)	(0.005)	(0.010)
Age Squared				-0.000**	-0.000**	-0.000
				(0.000)	(0.000)	(0.000)
Tenure at the Firm (Yrs)				-0.001	-0.001	0.013*
				(0.003)	(0.003)	(0.008)
Vocational Training (0/1)				-0.014	-0.014	-0.045
				(0.026)	(0.026)	(0.054)
Cognitive Score (0-4)					0.024***	0.044*
					(0.008)	(0.026)
Agreeableness (1-5)					-0.002	-0.021
					(0.011)	(0.033)
Conscientiousness (1-5)					-0.028**	-0.030
					(0.014)	(0.028)
Extraversion (1-5)					0.009	0.014
					(0.012)	(0.031)
Openness (1-5)					0.007	0.025
					(0.020)	(0.058)
Neuroticism (1-5) (reversed scale)					-0.017	0.036
					(0.013)	(0.033)
Log Firm Size			0.018			
			(0.021)			
Constant	0.334***	0.025	-0.011	-0.131	-0.029	-0.098
	(0.048)	(0.018)	(0.052)	(0.086)	(0.125)	(0.341)
Observations	1,285	1,285	1,285	1,285	1,285	1,285
Adjusted R^2	0.023	0.069	0.069	0.100	0.108	0.264
Subcounty FE	Yes	Yes	Yes	Yes	Yes	No
Firm FE	No	No	No	No	No	Yes
Dep Var Mean	0.360	0.120				
F-test Employee Char				0.210	0.0200	0.470

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. OLS regression coefficients. Standard errors (in parentheses) are clustered at the firm level. Sample: All employees interviewed in the follow-up survey (across three sectors). Dependent variable: A dummy equal to one if the employee left the firm for any reason (column 1) or to start-up their own firm in the same sector (columns 2-6), and zero otherwise. CW is a dummy for carpentry/metal fabrication.

Becoming an owner in grain milling involves overcoming a higher fixed cost, as shown in

Panel (d) of Figure 3, which is in line with firm owners being older in that sector. The role of skills in the career of employees is also different: consistent with the fact that employees in grain milling are more specialized, there are less opportunities to learn, as highlighted by the distributions in Figure 5, which all show lower learning in grain milling (note that average employee tenure in the three sectors is similar). Finally, again in line with specialization being more prevalent in grain milling, Figure A.3 shows that the main perceived difference of employees with respect to their owners are managerial skills, rather than practical skills and reputation, as it was the case in carpentry/metal fabrication. Consistent with this, when asked why they didn't start the firm a year earlier, grain milling owners cite lack of capital as the main reason (32%) but lack of practical skills is cited only as the third reason (11.3%), with family reasons being more important than practical skills (22.5%).

In sum, owners in carpentry/metal fabrication largely used to be employees, and so what differentiates the two is primarily skills and capital, which employees are able to accumulate during their time at the firm. On the other hand, grain milling owners typically did not use to work in the sector, and in line with this owners and employees are more different, and there is lower human capital accumulation taking place on the job in grain milling where employees are more specialized.

4 Model

We model a dynamic economy in discrete time and focus our analysis on steady states. Since we focus on steady states, we drop the subscript t unless necessary for clarity.

4.1 Environment

We first describe the environment of our economy.

Agents and Demographics. The economy is populated by a measure $N + 1$ of agents of which a measure 1 could potentially work in manufacturing. These agents, indexed by $i \in [0, 1]$, are the focus of our paper. They differ across three dimensions: schooling $s(i)$, cost of capital $r(i)$, and ability in the manufacturing sector $z(i)$, which we refer to simply as ability. Schooling as well as the cost of capital take on two values, high or low: $s \in \{\underline{s}, \overline{s}\}$ and $r \in \{\underline{r}, \overline{r}\}$. Schooling is a fixed attribute: it is drawn at birth and constant thereafter. The cost of capital follows a

Markov process with an absorbing state at $\underline{r}$:

$$r_{t+1}(i) = \begin{cases} r_t(i) & \text{w.p} \quad (1-\rho) \\ \underline{r} & \text{w.p} \quad \rho. \end{cases} \tag{4.1}$$

Individuals also draw an initial ability $z(i)$ at birth, which endogenously evolves over time as we describe below.

All agents have finite, stochastic lifetime. With constant probability δ, they die and are replaced by a new agent who draws an initial state from the unconditional joint distribution of schooling, cost of capital, and ability. Individuals have linear preferences over the aggregate consumption good C and discount the future at rate $\tilde{\beta}$. In each period of their lives, they supply one unit of labor inelastically. To simplify notation, we define $\beta \equiv \tilde{\beta}\delta$ to be the effective discount rate, taking into account the death probability. There is no storage technology or capital accumulation in the economy, so all output in period t must be consumed.

Individuals can start a firm and become entrepreneurs, or be employed as workers in the manufacturing sector m or an outside sector x. We define $\mathcal{I}_o$ to be the set of firm owners, while $\mathcal{I}_w$ and $\mathcal{I}_x$ are the sets of individuals i working in the manufacturing and outside sectors respectively.

Aggregate and Sectoral Output. Aggregate output Y is a composite of output from the manufacturing sector Y_m and from the outside sector Y_x. The outside sector is a stand-in for all other goods consumed in the economy. There is a competitive set of identical firms that use labor to produce output, according to a linear technology. The workforce in the outside sector is the sum of an exogenous component N and an endogenous component N_x, which is the cardinality of $\mathcal{I}_x$. The manufacturing sector is the core focus of analysis and should be interpreted as either carpentry, welding, or grain-milling. Manufacturing firms produce a homogeneous good – manufacturing output is therefore simply the sum of output produced by all the individuals that decide to set up a firm. The set of firm owners, all $i \in \mathcal{I}_o$, is itself an equilibrium object determined by the occupational choices.

$$Y = \left[\omega Y_m^{\frac{\iota}{\iota-1}} + (1-\omega) Y_x^{\frac{\iota}{\iota-1}}\right]^{\frac{\iota}{\iota-1}} \tag{4.2}$$

$$Y_x = A_x(N_x + N) \tag{4.3}$$

$$Y_m = \int_{i \in \mathcal{I}_o} y(i) di \tag{4.4}$$

The output of a manufacturing firm owned by some individual i' is produced using the labor of all individuals of the firm: the owner's, supplying one unit of labor, as well as hired workers',

supplying $n(i') - 1$ units of labor, where $n(i')$ is the size of the firm. Output is linear in total labor $n(i')$ with an endogenous productivity term $\mathbb{Z}(i')$, which we discuss below. That is, the output of the firm owned by some individual i' is $\mathbb{Z}(i')n(i')$. Production also requires $\chi(n)$ units of the aggregate manufacturing output, where $\chi(.)$ is an increasing and convex function. This can be thought of as purchasing or renting machines, renting a production space, or any other auxiliary costs that depend on the scale of the firm.

Labor Market. Every period, workers sell their one unit of labor to an intermediary in a spot market. The intermediary hires individual workers at a wage $w(z(i))$, bundles them, and sells a representative mass of workers to firms at wage $\overline{w}$.[17] Firms therefore have a choice only over the size of the firm $n(i')$; the composition of worker ability in the firm is exogenous from the perspective of the owner. It is equal to the distribution of types $z(i)$ in the endogenous set of workers $\mathcal{I}_w$.

The labor intermediary takes all wages as given and makes zero profits. Hence,

$$\overline{w} = \int_{i \in \mathcal{I}_w} w(z(i)) di \tag{4.5}$$

From the point of view of the firm, only $\overline{w}$ is relevant – this is the price at which they hire labor services. We refer to $\overline{w}$ as the average manufacturing wage. While $\overline{w}$ is uniquely determined in equilibrium, there are many wage functions $w(.)$ that could be sustained in equilibrium. This follows directly from the assumption of random matching – for every wage function $w(.)$ that satisfies (4.5), there is an equilibrium distribution of manufacturing workers. The specifics of the wage function – i.e. how the firm-level wage bill is distributed among all workers – is a primitive of the model that we will estimate directly from the data.

Firm-Level Productivity. The productivity of each firm is endogenous to the ability of all individuals working at the firm as well as how these individuals are assigned to production tasks within the firm. Producing a unit of gross output requires a series of step, some of which are more skill-intensive than others. For example, in order to sell a door, a carpenter has to discuss the order details with the customer and agree on a design, bargain a price and delivery time, buy the inputs, cut the wood, prepare it using a thickness planer, maintain the thickness planer, paint and finish the door, clean up, and deliver the finished product. D denotes the fraction of these tasks that are skill-sensitive.

The value of the unit of output depends on the identity of only the person performing

[17] The intermediary should not be interpreted literally. It is merely a modeling device which is analogous to assuming that firms randomly draw workers from the population. As we will explain in details in the model's characterization, this assumption simplifies the analysis and provides a high degree of flexibility to study the relationship between exogenously determined wage rigidity and the endogenous organization of production.

the skill-sensitive tasks. For example, the door will only be as good as the carpentry skills of the person designing and finishing it. The skills of the person cleaning up the shop after production on the other hand have little influence on the quality of the final output. By default, each individual is assigned the full set of tasks associated with producing one unit of output. Tasks can then be unbundled, that is, delegated to other individuals within the firm. After tasks are unbundled, the value of the final output is equal to the (weighted average) ability of those who perform the complex tasks, minus some output that is lost as a delegation cost $\kappa(.)$.

We now describe the production and delegation problem in more detail. Let $\mu(i, i'')$ be the fraction of complex tasks of individual i that are performed by individual i''. The productivity of a firm of size n, owned by individual i' with a set of workers $\mathcal{I}_w(i')$ is given by

$$\mathbb{Z}(i') = \frac{1}{n} \int_{i' \cup \mathcal{I}_w(i')} \Big[\tilde{y}(i) - \kappa(\varphi(i), i') \Big] di \tag{4.6}$$

$$\text{where} \qquad \tilde{y}(i) = \int_{i' \cup \mathcal{I}_w(i')} z(i'') \mu(i, i'') di'' \qquad \forall\, i \in \{i' \cup \mathcal{I}_w(i')\} \tag{4.7}$$

$$\varphi(i) = (1 - \mu(i, i)) \qquad \forall\, i \in \{i' \cup \mathcal{I}_w(i')\} \tag{4.8}$$

As we describe below, the assignment function $\mu(i, i'')$ is chosen by the owner to maximize productivity $\mathbb{Z}(i')$. In order to be *feasible*, an assignment function must satisfy two constraints. First, all complex tasks of all individuals must be performed by someone in the firm (4.9). Second, each individual can at most spend her entire time budget (=1) on complex tasks (4.10). We define $\theta(i)$ to be the share of time individual i spends on complex tasks. Notice that the identity of the individuals performing the non-complex tasks is irrelevant. Since all individuals supply one unit of their time inelastically, all non-complex tasks are completed by construction.

$$\int_{i' \cup \mathcal{I}_w(i')} \mu(i, i'') di'' \geq 1 \qquad \forall i \in \{i' \cup \mathcal{I}_w(i')\} \tag{4.9}$$

$$\int_{i' \cup \mathcal{I}_w(i')} \mu(i'', i) di'' \equiv \theta(i) \leq 1 \qquad \forall i \in \{i' \cup \mathcal{I}_w(i')\} \tag{4.10}$$

Evolution of Ability. Individual ability evolves over time for both owners and workers in the manufacturing sector. The ability of firm owners evolves according to a "learning-by-doing"

process:

$$z_{t+1}(i') = z_t(i')\, e^{\eta_t(i')}, \tag{4.11}$$

where $\eta_t(i') \sim N(\mu(s(i')), \sigma)$, with $\mu(\overline{s}) \geq \mu(\underline{s}) \geq 0$. The higher individual's level of schooling, the more they are able to learn.

Workers also learn by doing and additionally learn from the owner of the firm in which they work, with the parameter $\lambda \in [0, 1]$ modulating the strength of the two sources of learning. Their ability evolves according to

$$z_{t+1}(i) = z_t(i)^{1-\lambda} z_t(i')^{\lambda} e^{\nu(i,i')\eta_t(i)}, \tag{4.12}$$

where $\eta_t(i) \sim N(\mu(s(i)), \sigma)$, just as for firm owners, and $\nu(i, i') = \left(\frac{\theta(i)}{\theta(i')}\right)^{\nu}$ with $\nu \geq 0$. The parameter ν determines the extent to which learning depends on the amount of time spent on managerial tasks: carpentry ability increases faster the more time workers spend on finishing doors rather than sweeping floors.[18] Overall workers could learn faster firm owners due to knowledge diffusion (especially if λ is high), but slower if they spend less time on managerial tasks (especially if ν is high)

4.2 Choices

We next turn to the optimal choices that economic agents in this model make. Each individual i has three state variables: $\{z(i), r(i), s(i)\}$. Conditional on occupational choice and hence the sets $\mathcal{I}_o, \mathcal{I}_w,$ and $\mathcal{I}_x$, the assignment of workers to tasks and the resulting firm productivity are a function of z only. For ease of exposition, we thus reduce the dimensionality of the within-period problem of the owners to z only. Analogous to the partition of individuals i, we define $\mathcal{Z}_o, \mathcal{Z}_w,$ and $\mathcal{Z}_x$ to be the sets of productivities in each of the three occupations. The level of schooling and the cost of capital are relevant for the occupational choice, which we describe below, and for the dynamic evolution of ability in the manufacturing sector.

Owner Problem (Within-Period). Consider a firm owner with ability z'. To maximize profits, she chooses the mass of workers to hire, $n(z')$, and how to assign her own unit of time as well as the one of her workers to tasks. The task assignment is summarized by the function $\mu(z, z''), \quad \forall (z, z'') \in \{z' \cup \mathcal{Z}_w\} \times \{z' \cup \mathcal{Z}_w\}$. She solves

[18] Rather than defining $\nu(i, i')$ to be a function of both $\theta(i)$ and $\theta(i')$, we could equivalently let the law of motion of firm owners (and the one of workers) depend symmetrically on the time spent on managerial tasks. The two fomulations are identical up to a normalization.

$$\pi(z') = \max_{\{\mu(z,z''),n\geq 1\}} \mathbb{Z}\left(\mu(z,z''),n;z'\right)\ n - \overline{w}(n-1) - P_m\chi(n) \tag{4.13}$$
$$\text{s.t.}(4.6),(4.7),(4.8),(4.9),(4.10)$$

The constraints and functional forms faced by the owners are the same as those described in the previous section, but replacing the set of workers – $\mathcal{I}_w(i')$ – with the set of ability of those workers – $\mathcal{Z}_w(i')$. We include the full problem description in Appendix B.

If choosing to be a worker – either in the manufacturing or outside sector – individuals make no more decisions that period.

Occupational Choice (Dynamics). In each period, individuals choose whether to work in the outside sector or in manufacturing. In the latter case, they also decide whether to start or continue operating a firm, or to be a worker. Starting a firm requires paying a fixed entry cost $r(i)K$, denoted in units of the aggregate manufacturing good. $r(i)$ is the cost of capital of individual i and K is the startup capital needed to set up the enterprise. If individuals were firm owners in the previous period as well, they can keep operating their business without paying the fixed cost again.

The value of the worker problem depends on her index i only through the time-varying ability $z_t(i)$ and cost of capital $r_t(i)$, and the time-invariant schooling $s(i)$. The value solves

$$V(z_t,r_t,s,\mathbb{I}_{o,t-1}) = \max\left(\underbrace{V_x(z_t,r_t,s)}_{\textbf{Outside Sector}}, \underbrace{V_w(z_t,r_t,s)}_{\textbf{Worker}}, \underbrace{V_o(z_t)}_{\textbf{Owner}} - \underbrace{(1-\mathbb{I}_{o,t-1})(P_m r_t K)}_{\textbf{Startup Cost}}\right), \tag{4.14}$$

where $\mathbb{I}_{o,t-1}$ is an indicator that takes on value 1 if individual i was an owner in period $t-1$ and 0 otherwise where the values of working in the outside sector, working in manufacturing, and owning a firm are

$$\begin{aligned} V_x(z_t,r_t,s) &= w_x(s) + \beta\mathbb{E}_r\left[V(z_{t+1},r_{t+1},s,0)\right] \\ V_w(z_t,r_t,s) &= w(z_t) + \beta\mathbb{E}_{z,r}\left[V(z_{t+1},r_{t+1},s,0)\right] \\ V_o(z_t) &= \pi(z_t) + \beta\mathbb{E}_{z,r}\left[V(z_{t+1},r_{t+1},s,1)\right]. \end{aligned}$$

Workers in either sector receive their wage income, which could depend on schooling s in the outside sector and on ability z in manufacturing. For workers in the outside sector, their next period value depends only on the realization of their cost of capital r since their ability z is constant while working there. The ability of workers in the manufacturing sector,

instead, evolves stochastically over time and is a function of the firm owner with whom they are randomly matched, the resulting task allocation, and a random shock, as shown in (4.12).

Firm owners receive the flow profit $\pi(z)$each period, which is the solution of the owners' problem (4.13). Their future value depends on r via the option value of becoming a worker and re-opening a firm at a later date, and on the evolution of the ability z which follows the stochastic law of motion in (4.11).

The solution to problem (4.14) gives the occupational choice indicators $\mathbb{I}_o(z,r,s)$, $\mathbb{I}_w(z,r,s)$, and $\mathbb{I}_x(z,r,s)$ which take value equal to 1 if an individual with state (z,r,s) chooses to become a firm owner, a worker in manufacturing, or a worker in the outside sector respectively.

4.3 Equilibrium

Finally, we describe the notion of equilibrium. We solve for the long-run steady state equilibrium of the economy. While the overall economy is stationary, each individual follows a stochastic life-cycle. Agents die and are replaced by newly born ones. After birth, they change occupation over time as their ability and cost of capital evolve. Despite these rich dynamics at the individual level, the density of individuals ability, schooling, and cost of capital is constant in each occupation. We define these distributions to be $g_o(z,r,s)$, $g_w(z,r,s)$, and $g_x(z,r,s)$, for owners, workers in manufacturing and workers in the outside sectors.[19]

Definition of Competitive Equilibrium *The competitive equilibrium is given by relative price of the manufacturing good P_m, average manufacturing wage $\overline{w}$, firm sizes and output price for each firm owner ability type $\{p(z'),n(z')\}_{\forall z'}$, task assignment chosen by each firm owner z' for each pair (z,z'') of individuals in the firm (including the manager herself) $\{\mu(z,z'';z')\}_{\forall(z,z',z'')}$, occupational choices $\mathbb{I}_o(z,r,s)$, $\mathbb{I}_w(z,r,s)$, $\mathbb{I}_x(z,r,s)$, and stationary distributions $g_o(z,r,s)$, $g_w(z,r,s)$, and $g_x(z,r,s)$ such that:*

1. *firm owners choose firm size and task assignment to maximize profits solving (4.13);*
2. *individuals choose their occupation to maximize their value according to (4.14);*
3. *the producer of the aggregate output Y maximizes profits;*
4. *output prices are $p(z') = \left(\frac{y(z')}{Y_m}\right)^{\frac{1}{\sigma}} P_m$ and $P_m = \left(\frac{\omega}{1-\omega}\right)\left(\frac{Y_m}{Y}\right)^{\frac{1}{\iota}}$;*
5. *the labor market clears: $\sum_r \sum_s \int n(z) g_o(z,r,s) dz = \sum_r \sum_s \int g_w(z,r,s) dz$;*
6. *$g_o(z,r,s)$, $g_w(z,r,s)$, and $g_x(z,r,s)$ are stationary and consistent with the occupational choice, and the laws of motion for z and r shown in (4.11), (4.12), and (4.1).*

[19] Each density integrate to the total mass of individual in a given occupation, for example $\sum_r \sum_s \int_{i\in\mathcal{I}_o} g_o(z(i),r(i),s(i))di$ is equal to the mass of firms owners in the economy.

4.4 Characterization

We study the allocation of talent within and between firms, focusing on how it is affected by the delegation cost $\kappa(.)$. Towards this goal, we first analyze the profit maximization problem of the firm owner, then solve for the occupational choice, and finally we combine the two and focus on the overall equilibrium of the economy. All proofs of the results are relegated to Appendix B.

Throughout this section, we work under two sets of assumptions. The first one specifies a functional for the delegation cost as well as the cost of firm size; we will use this functional form – up to a normalization – for the estimation as well. The second one is a set of parametric assumptions that simplify the exposition; they will be relaxed in the quantitative exploration of the next sections.

ASSUMPTION **1.** The cost to delegate a share φ of complex tasks is $\kappa(\varphi) = (1 + 1/\kappa_1)^{-1} \kappa_0^{1/\kappa_1} \varphi^{1+1/\kappa_1}$ and the cost to set up a firm of size n is $\chi(n) = (1 + 1/\chi_1)^{-1} \chi_0^{1/\chi_1} n^{1+1/\chi_1}$.

ASSUMPTION **2.** Parameters of the model satisfy the following conditions:

1. The constraint (4.10) is slack for all workers and firm owners, i.e. in equilibrium no one spends all their time working on complex tasks: $\theta < 1$ for all ..
2. All workers in manufacturing are paid the same wage: $w(z) = \overline{w}$ for all z.
3. Workers do not learn from managers: $\lambda = 0$.

Assumption 1 is useful to isolate two key parameters of interest, the level of the cost of delegation κ_0 and of the cost of firm size χ_0. Part 1 of Assumption 2 is motivated by the empirical evidence showing that even the owners of the largest firms spend some of their time performing simple tasks. It is a joint assumption on parameters of the model.[20] Part 2 of Assumption 2 allows us to cleanly focus on how learning and the occupational choice interact.[21] The last assumption, instead, simplifies the exposition since it equates the rate of learning of all manufacturing employees and owners.

Within-firm Organization. We first study the within-firm organization. Lemma 1 characterizes the solution to the profit maximization problem. We focus on three key outcomes – labor specialization, firm size, and resulting firm productivity – and how they depend on the ability of the firm owner as well as on the costs of delegation (κ_0) and firm size (χ_0). We define labor specialization as the difference between how much time the firm owner and the average

[20] In the estimated model in the next section, this assumption will hold

[21] It is also broadly consistent with the data in the sense that wage heterogeneity among workers is small, especially if compared to the heterogeneity in firms profits.

worker spend performing complex tasks; this is our main measure of task allocation within the firm. Figures 6 and 7 illustrate the Lemma.

LEMMA **1** (Within-Firm Organization)**.** *The solution to the profit maximization problem for a manager of ability z', matched with workers drawn from a distribution $f(z)$ such that $z' \geq \max\{z|f(z) > 0\}$ satisfies the following:*

1. *The complex tasks performed by a worker of ability z and by the firm owner z' are*

$$\theta(z, z'; \kappa_0, \chi_0) = D\left(1 - \frac{1}{\kappa_0}\left(z' - z\right)^{\kappa_1}\right) \tag{4.15}$$

$$\theta(z', z'; \kappa_0, \chi_0) = D\left(1 + \frac{n(z'; \kappa_0, \chi_0) - 1}{\kappa_0}\int \left(z' - z\right)^{\kappa_1} f(z)dz\right). \tag{4.16}$$

   As a result, both a decline in κ_0 or in χ_0 increase labor specialization. The former also directly, while the latter only through its effect on firm size.

2. *Firm size $n(z'; \kappa_0, \chi_0)$ is increasing in z' and declining in both κ_0 and χ_0. Moreover, if $\kappa_0 \to \infty$, all firms have identical size $n(z') = \frac{\left(\int zf(z)dz - w\right)^{\chi_1}}{\chi_0}$; while if $\kappa_0 = 0$, optimal size depends only on the owner's ability z' and is independent of worker ability $f(z)$: $n(z') = \frac{(z'-w)^{\chi_1}}{\chi_0}$.*

3. *Firm productivity $\mathbb{Z}(z'; \kappa_0, \chi_0)$ is decreasing in κ_0 and increasing in χ_0. Moreover, if $\kappa_0 \to \infty$, $\mathbb{Z}(z') = \frac{z' + (n(z')-1)\int zf(z)dz}{n(z')}$; while if $\kappa_0 = 0$, $\mathbb{Z}(z') = z'$.*

The key building block of Lemma 1, from which all the results derive, is the allocation of tasks within the firm. In deciding who should complete the complex tasks, the firm owner faces a simple trade-off between the productivity gains from allocating individuals based on their comparative advantage – i.e. of having the complex tasks assigned to the most skilled individuals – and the cost of delegation. Consider an individual with ability z. The benefit of delegating a marginal complex task from z to any individual with ability $z'' > z$ is simply equal to the difference in abilities $z'' - z$.[22] The cost of delegation $\kappa(\varphi(z))$ is increasing in the share of tasks delegated. At the optimum, the marginal benefits and costs must offset each other, giving the condition $(\kappa_0\varphi(z))^{\frac{1}{\kappa_1}} = z'' - z$. This condition must hold for any z'' who performs complex tasks for z.

Note that the cost of delegation $\kappa(\varphi(z))$ depends only on the total share of tasks individual z has delegated, but not on the identity of the individual z'' to whom these tasks are delegated. Given that the productivity benefits of delegating are increasing in z'', it is optimal to allocate all the complex tasks to the most skilled individual in the firm – the firm owner herself. Of

[22]This follows directly from the production function in Equation (4.7), which states that the productivity of each unit of output is a function of the ability of the person completing the complex tasks D.

course, this is possible only as long as she has enough time to complete these tasks; Assumption 2 guarantees that this is always the case.

This argument can be used to formally derive the equations (4.15) and (4.16) and it encapsulates the key driver of labor organization within the firm: workers delegate complex tasks to the firm owner as long as the marginal productivity benefit of doing so is higher than the cost of delegation, and the firm-owner takes over the responsibility of solving all complex tasks left over from the workers. Labor thus specializes according to its comparative advantage, and the cost of delegation κ_0 modulates to the extent to which this happens.

Labor specialization and optimal firm size are closely intertwined. On the one hand, there is limited scope for specialization in small firms: there are simply not that many complex tasks for the owner to perform. On the other hand, a high cost of delegation reduces the returns to setting up large firms: when delegation is costly, the owner cannot leverage her managerial ability by performing the complex tasks of her workers and increasing their productivity.

Firm productivity ultimately depends on labor specialization and the size of the firm. In general, is it a function of the ability of the owner and all workers in the firm, weighted by their respective allocation of complex tasks. By varying the delegation cost κ_0, our model of firm production can capture anything from *self-employment within the firm* to the standard **?** model.

When delegation is prohibitively costly ($\kappa_0 \to \infty$), every individual in the firm performs her own complex tasks as there is no scope for labor specialization. This is what we refer to as *self-employment within the firm*. Firm productivity is simply the average of the managerial abilities of workers and firm owner. In this extreme case, the only reason for firms to exist is to share the fixed of entry. Firm size is entirely pinned down by the cost of size $\chi(n)$.

Instead, when $\kappa \to 0$, individuals fully sort to tasks based on their comparative advantage. There is full specialization of labor: the most skilled individual (the owner) solves all the complex tasks. As a result, the ability of workers is irrelevant, and firm productivity is only a function of the skills of the firm owner. This closely resembles the Lucas (1978) model. Firms are not only a means to share capital costs, but also to leverage the talent of the most skilled individuals in the economy.

In general, firm productivity is higher the lower is the delegation cost and hence the more there is labor specialization in the firm. However, the relationship between specialization and productivity need not always be positive: it depends on what drives the observed specialization. A decline in the cost of firm size (χ_0) does not affect the time each worker spends on the complex tasks, while it increases (mechanically) the overall number of residual complex tasks to be completed by the owner, thus leading to an overall increase in specialization. In this case, firm productivity *decreases* as specialization increase since it is diluted by the larger number of workers, who are all less skilled than the owner.

Overall, Lemma 1 shows that in our model, the notion of what a firm is crucially depends on the delegation cost and the resulting internal organization of the firm. Using κ_0, we can trace out organizational forms between the two extremes of self-employment in the firm and the Lucas (1978) model.

Occupational Choice. In Lemma 1, we assumed that firm owners are more skilled than workers. We now show that this is an equilibrium outcome of the model and study occupational choice in more detail. Lemma 2, illustrated in Figure 8, characterizes the occupational choice and how it depends on individual ability z, schooling s, and the cost of capital r.

LEMMA **2** (Occupational Choice.)**.** *The solution to the occupational choice problem yields the following:*

1. *There exist two cutoffs $z_2(r,s) \geq z_1(r,s)$ $\forall(s,r)$ such that a newly-born individual of ability z chooses to be a firm-owner if $z > z_2(r,s)$, to be a worker in manufacturing if $z \in [z_1(r,s), z_2(r,s)]$, and to be a worker in the outside sector if $z < z_1(r,s)$.*

2. *The probability that a newly-born individual chooses to be a firm owner at time $t+1$ – i.e. in the second period alive – is a (weakly) increasing function of her ability at time t, z_t, with positive jumps at $z_2(r,s)$, $z_1(r,s)$, and $z_0(r,s)$. The latter is a cutoff such that individuals with $z_t > z_0(r,s)$ and $r_t = \underline{r}$ would start a firm at $t+1$ if their cost of capital declines.*

3. *Define $P_o(s,a)$ to be the share of individuals of schooling s and age a that chooses to be firm owners. $P_o(s,a)$ satisfies $\forall a$: i. $P_o(\overline{s},a) > P_o(\underline{s},a)$, ii. $\frac{\partial P_o(s,a)}{\partial a} \geq 0$, and iii. $\frac{\partial P_o(\overline{s},a)}{\partial a} \geq \frac{\partial P_o(\underline{s},a)}{\partial a}$*

The first part of Lemma 2, in Figure 8a, shows that our model features the familiar sorting of talent into occupations by their skill-sensitivity. Firm owners are the only group for whom the managerial ability z directly affect flow income.[23] While being a worker in either sector, an individual's current managerial ability z only matters via the option value of starting a firm in subsequent periods. The returns to managerial ability therefore depend on the probability that they will become firm owners. Working in the manufacturing sector increases that probability via learn-by-doing, relative to working in outside the outside sector.

The second part of the Lemma, illustrated in Figure 8b, describes the occupational choice in more detail. We look at the sample of individuals that have a high cost of capital $\overline{r}$ in their first period of life t, and plot the probability that they start (or keep operating) a firm at $t+1$. There are four distinct groups of people. The lowest skilled ones ($z < z_0(r,s)$) are employed

[23] This is due to Assumption 2, which we will relax in the quantification.

in the outside sector and would not start a firm even if their cost of capital becomes low.[24] The next group of workers in the outside sector ($z \in [z_0(r,s), z_1(r,s))$) would become firm owners if their cost of capital is reduced to $\underline{r}$, which happens with probability ρ. Workers in the manufacturing sector – the third group – would start a firm even with $\overline{r}$ if their managerial ability increases enough (through learning by doing). This additional possibility generates the discrete probability increase at $z_1(r,s)$). There is another jump at $z_2(r,s)$). Individuals to the right of this threshold are firm owners in t already. They have already paid the sunk cost to start a firm and are hence more willing to remain owners.

Finally, Figure 8c shows that individuals are more likely to become firm owners as they age, and that this is more pronounced for individuals with high levels of schooling. There are several reasons behind this result: i. the average cost of capital declines over the life-cycle; ii. managerial ability increases over the life-cycle as individuals learn-by-doing – this is true unless they are in the outside sector –; iii. after individuals have paid the sunk cost to start a firm, they are less likely to transition back into being workers. These three forces are even more pronounced for individuals with high levels of schooling for two reasons. First, they have a higher probability of transitioning to the low cost of capital $\underline{r}$. The second is related to ability and learning. Individuals with high schooling hey have higher managerial ability at birth and learn faster, both of which endogenously makes them more likely to work in the manufacturing sector and learn-by-doing.

Equilibrium and Aggregate Implications. So far, we have considered the solution to the individual choice problems. Next, we turn to the overall economy and study the aggregate implications of a decline in the delegation cost.

Proposition **1** (Aggregate Implications of a Decline in Delegation Cost)**.** *Let $\mu = \mu_w = \sigma = 0$ and $\underline{r} = \overline{r}$ so that the state for each individual is constant over her life-cycle. Then, a decline in κ_0 yields:*

1. *an increase in labor specialization: $\theta(z')$ increases for all owners z' and $\theta(z)$ decreases for all workers z;*

2. *an increase in the average firm size: $\overline{n} \equiv \sum_r \sum_s \int n(z') g_o(z', r, s) dz$;*

3. *an increase in the average ability of firm owners: $z_2(r,s)$ increases $\forall (r,s)$;*

4. *an increase in the aggregate productivity $\overline{\mathbb{Z}} \equiv \sum_r \sum_s \int \mathbb{Z}(z') n(z') g_o(z', r, s) dz$;*

5. *an increase in the equilibrium manufacturing wage $\overline{w}$;*

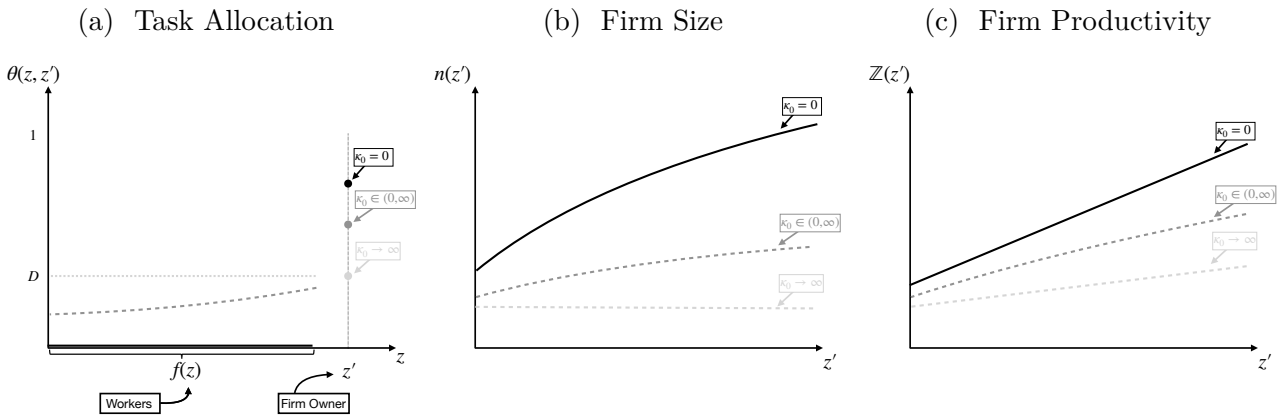
[24] For ease of exposition, we are assuming that $z_0(r,s) > z_1(r,s)$, but, of course, this does not have to be the case in equilibrium. The overall insights are, nonetheless, unchanged.

6. a higher return to managerial ability: $\frac{\partial \pi(z')}{\partial z'}$ *increases.*

Proposition 1 summarizes the effect of a decline in delegation cost on the economy. When the delegation cost is high, the economy is made of many small firms, owned by low productivity managers, and internally organized with limited specialization. The result is low aggregate productivity, low demand for workers, and consequently low wages. The returns to managerial ability are limited as firm owners are not able to leverage their talent.

Reducing the delegation cost transforms the way firms are organized internally with effects that ripple through the economy in equilibrium. Higher labor specialization increases firm productivity, and thus the demand for labor. As a result, wages increase, leading some marginal firm owners to become workers. This further increases aggregate productivity through a classic selection effect. Overall, managerial ability is highly priced in the economy, as talent can be leveraged by taking over more and more complex tasks.

Figure 6: Within-Firm Organization and Delegation Cost κ_0

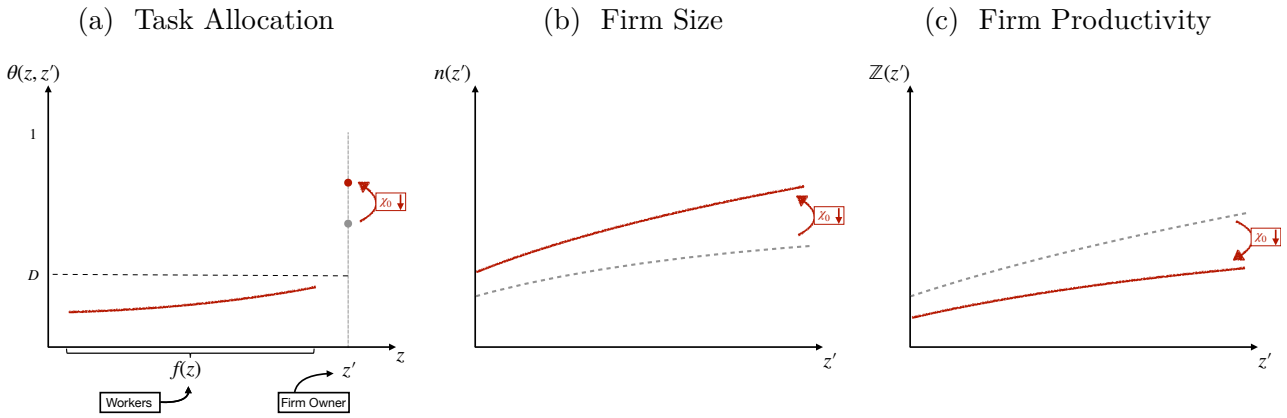


Notes: TBD

5 Estimation

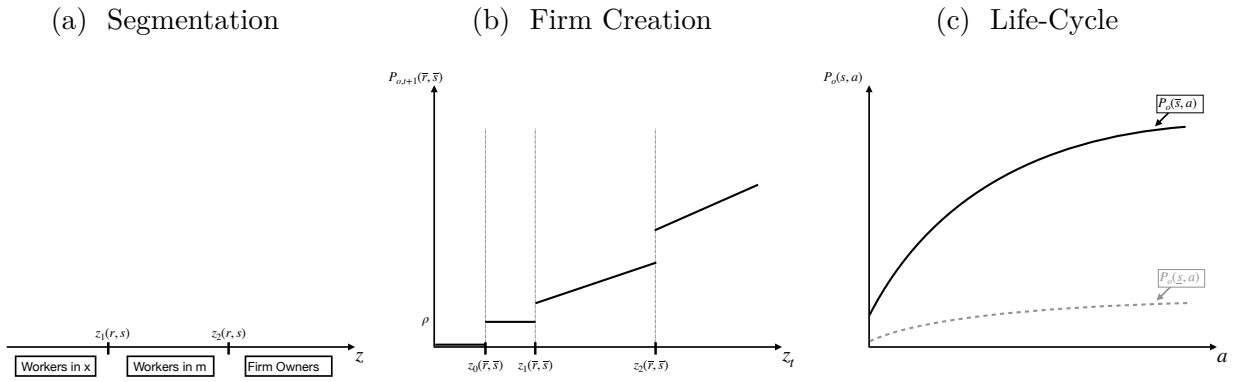
TBC

Figure 7: Within-Firm Organization and Cost of Firm Size χ_0



Notes: TBD

Figure 8: Occupational Choice



Notes: The second panel displays the probability that an individual tomorrow will be a firm owner as a function of today ability. We plot the case with $r = \overline{r}$ and $s = \overline{s}$, but the figure looks qualitatively identical for $s = \underline{s}$

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A Appendix - Data

A.1 Attrition from the follow-up surveys

Table A.1: Attrition table – Owners

Dependent variable: Attritted (0/1)						
	(1)	(2)	(3)	(4)	(5)	(6)
CW (0/1)	-0.221***	-0.247***	-0.240***	-0.215***	-0.280***	-0.254***
	(0.052)	(0.051)	(0.051)	(0.056)	(0.090)	(0.095)
Manager Ability (Std.)	0.027		0.033*	0.008		0.019
	(0.017)		(0.017)	(0.043)		(0.043)
Firm Size		-0.008*	-0.010**		-0.012	-0.012
		(0.005)	(0.005)		(0.009)	(0.009)
CW × Man. Ability (Std.)				0.022		0.016
				(0.046)		(0.047)
CW × Firm Size					0.005	0.003
					(0.010)	(0.010)
Mean of dep. var.	0.322	0.322	0.322	0.322	0.322	0.322
Subcounty FE	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.050	0.049	0.054	0.049	0.049	0.052
Observations	1,101	1,101	1,101	1,101	1,101	1,101

Notes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. OLS regression coefficients, robust standard errors in parentheses. Sample: The owners of 1,101 firms with phone numbers from the baseline survey. Dependent variable: A dummy equal to one if the firm was successfully interviewed in the follow-up survey, and zero otherwise.

Owner survey In the follow-up phone survey conducted in Spring 2022, the owners of 1,101 firms with phone numbers from the baseline survey were targeted. The attrition rate was 32%, which is in line with other firm surveys in developing countries.[25] In general, owners in larger firms and those with higher managerial ability showed less attrition. In addition, attrition was higher in the grain milling sector than in other two sectors. However, there was no differential attrition in terms of size and managerial ability across sectors, limiting sample selection bias in evaluating dynamics by comparing the three sectors.

[25]For example, the attrition rate is 38% in McKenzie and Woodruff (2008), 36% in Dupas and Robinson (2013) and 45% in McKenzie, Assaf, and Cusolito (2017). The business training experiments summarized in McKenzie and Woodruff (2014) show attrition rates ranging from 5% to 46%.

Table A.2: Attrition table – Employees

VARIABLES	(1) attrited	(2) attrited	(3) attrited	(4) attrited	(5) attrited	(6) attrited
CW	-0.098**	-0.104**	-0.090**	-0.094**	-0.065	
	(0.042)	(0.043)	(0.043)	(0.042)	(0.039)	
Manager Ability (Std)	-0.009		-0.007	-0.009	-0.012	
	(0.015)		(0.015)	(0.015)	(0.014)	
Years of Schooling			-0.005	-0.006	-0.008**	-0.009
			(0.004)	(0.004)	(0.004)	(0.007)
Age			0.003	0.002	-0.003	-0.007
			(0.008)	(0.008)	(0.007)	(0.014)
Age Squared			-0.000	-0.000	0.000	0.000
			(0.000)	(0.000)	(0.000)	(0.000)
Tenure at the Firm (Yrs)			-0.012***	-0.012***	-0.009***	-0.006
			(0.004)	(0.004)	(0.003)	(0.007)
Vocational Training (0/1)			0.037	0.045	0.037	0.029
			(0.038)	(0.037)	(0.036)	(0.060)
Cognitive Score (0-4)				-0.018*	-0.009	0.008
				(0.011)	(0.010)	(0.018)
Agreeableness (1-5)				0.027	0.020	0.007
				(0.017)	(0.016)	(0.031)
Conscientiousness (1-5)				0.021	0.030*	0.040
				(0.019)	(0.018)	(0.028)
Extraversion (1-5)				0.009	0.011	0.040
				(0.015)	(0.015)	(0.024)
Openness (1-5)				0.016	0.009	-0.015
				(0.023)	(0.022)	(0.034)
Neuroticism (1-5) (reversed scale)				-0.010	-0.013	0.002
				(0.017)	(0.016)	(0.031)
Log Firm Size		-0.019				
		(0.027)				
Owner attrited					0.050	
					(0.032)	
Constant	0.482***	0.521***	0.558***	0.372**	0.387**	0.336
	(0.038)	(0.071)	(0.130)	(0.182)	(0.165)	(0.291)
Observations	2,177	2,177	2,177	2,177	2,177	2,177
Adjusted R^2	0.038	0.039	0.048	0.051	0.137	0.345
Subcounty FE	Yes	Yes	Yes	Yes	Yes	No
Firm FE	No	No	No	No	No	Yes
Dep Var Mean	0.410					
F-test Employee Char			0	0	0.0100	0.750

Notes: *** p < 0.01, ** p < 0.05, * p < 0.1. OLS regression coefficients. Standard errors (in parentheses) are clustered at the firm level. Sample: All employees interviewed in the follow-up survey (across three sectors). Dependent variable: A dummy equal to one if the employee was successfully interviewed, and zero otherwise.

Employee survey In the follow-up phone survey wave, we leveraged the dyadic nature of our baseline survey data and attempted to interview 2,177 employees who originally worked for 899 of our sample firms in 2018-19. The resulting attrition rate was 41%, which is reasonable considering the survey mode (phone interviews) and over a three-year gap since we originally interviewed these employees. To try and lower attrition from the panel survey, our field team reached out to successfully interviewed firm owners for assistance to contact their unreachable employees (and vice-versa). Table A.2 highlights whether employee and firm characteristics are predictive of attrition from the employees' sample. On average, we were 9-10 percentage points less likely to interview employees in the grain milling sector compared to carpentry and welding. This pattern is linked to differential attrition among *both* firm owners and employees in the milling sector (column 4). The managerial ability of the firm owner and the size of the firm (in 2018-19) are not correlated with higher attrition among employees. Moreover, employee skills do not jointly predict higher attrition after controlling for firm fixed effects (p-value of the F-test: 0.75).

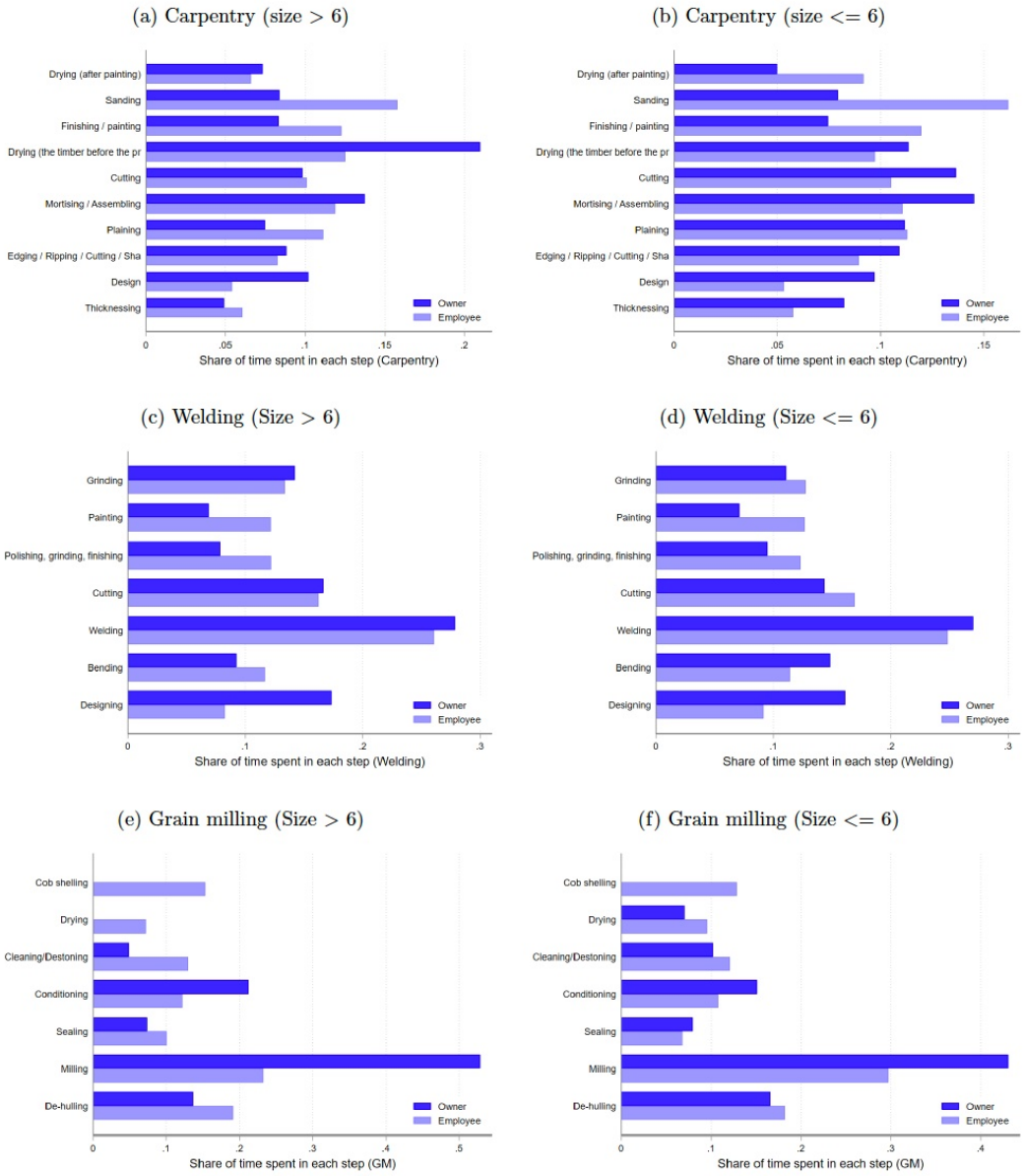
A.2 Additional Tables and Figures

Table A.3: Wage returns from involvement in non-production activities

	(Log) Salary		(Log) Hourly Wage	
	(1)	(2)	(3)	(4)
Timeshare on	0.118*	0.297***	-0.080	-0.015
Non-production Activities (0∼1)	(0.066)	(0.073)	(0.076)	(0.086)
Manager Ability (Std.)	0.080***		0.038**	
	(0.019)		(0.019)	
Age	0.015***	0.009***	0.020***	0.013***
	(0.002)	(0.002)	(0.002)	(0.002)
Years of Schooling	0.024***	0.026***	0.024***	0.031***
	(0.005)	(0.006)	(0.005)	(0.007)
Tenure at the Firm (Yrs.)	0.024***	0.029***	0.009*	0.023***
	(0.005)	(0.006)	(0.005)	(0.006)
Vocational Training (0/1)	0.089*	0.125**	0.085	0.138**
	(0.047)	(0.056)	(0.055)	(0.063)
Subcounty FE	Yes	No	Yes	No
Sector FE	Yes	No	Yes	No
Firm FE	No	Yes	No	Yes
Adjusted R^2	0.292	0.540	0.228	0.490
Observations	2,350	2,350	2,338	2,338

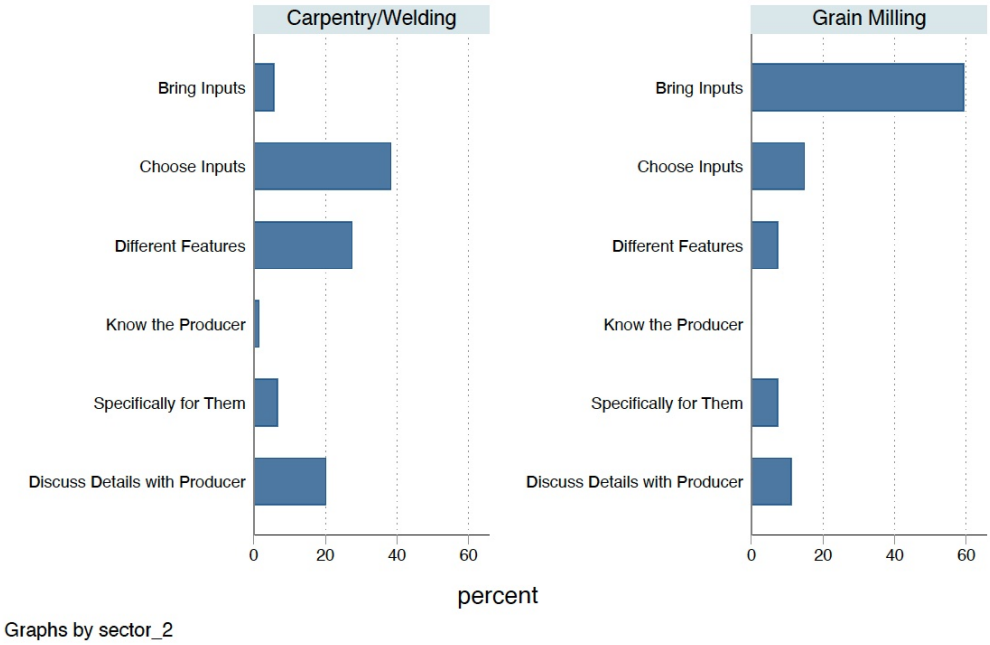
Notes: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. OLS regression coefficients. Standard errors (in parentheses) are clustered at the firm level in Columns (1) and (3), while robust standard errors are used in Columns (2) and (4). Sample: All employees interviewed in the baseline survey (across three sectors). Time share on Non-production activities: Time spent on non-production activities / (Total time – inactive time).

Figure A.1: Labor specialization across production steps



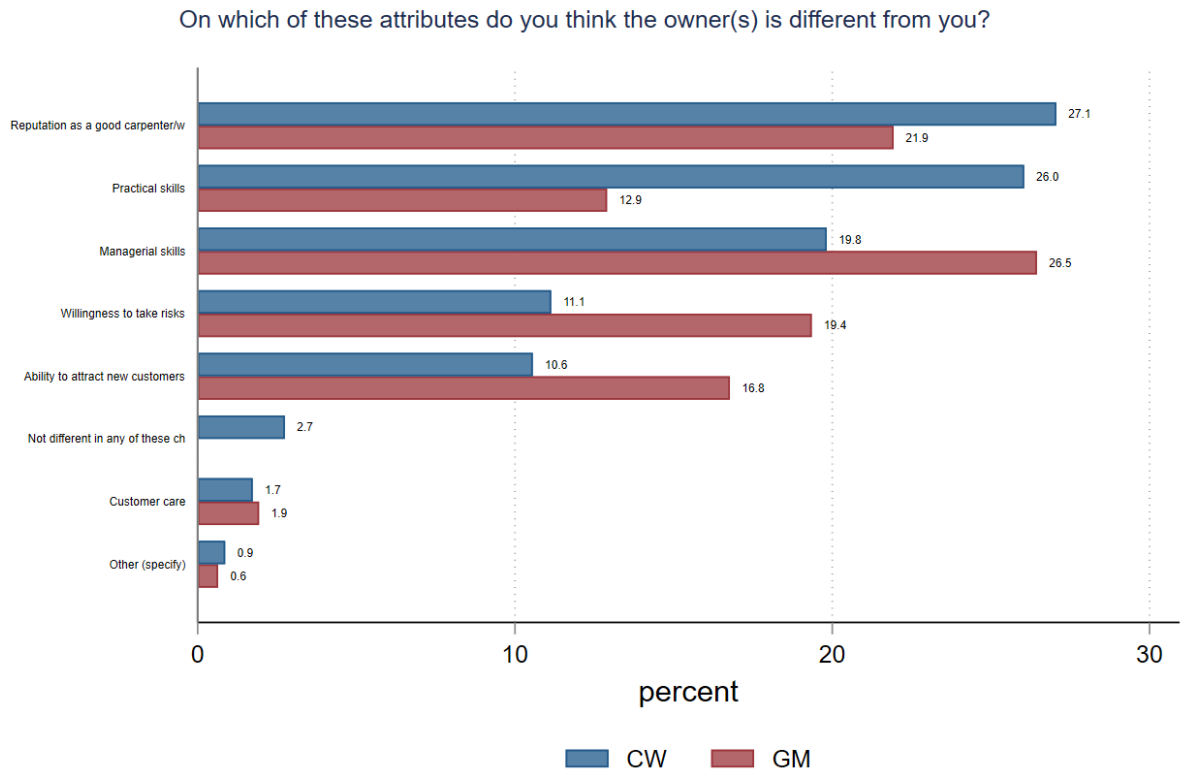
Notes: This figure shows the share of production time spent by owners (dark bars) and employees (light bars) in the pre-specified production steps for the main product. Production steps are ranked from the least complex to the most complex, using survey questions on the perceived ability of employees in conducting a given production steps.

Figure A.2: Reasons for customization



Notes: Figure A.2 shows reasons for product customization as reported by firm owners in carpentry and metal fabrication (left panel) and in grain milling (right panel). The vertical axis displays various reasons for customization, e.g. the customer brings their own inputs. Data is from the follow-up survey of firm owners.

Figure A.3: Employees' perceptions about differences with owners



Notes: This figure shows employees' perceptions about why the owner is different from them. Blue bars are for carpentry/metal fabrication. Red bars for grain milling. Data is from the follow-up survey of employees.

Figure A.4: Employees' perceptions on skill accumulation by firm size

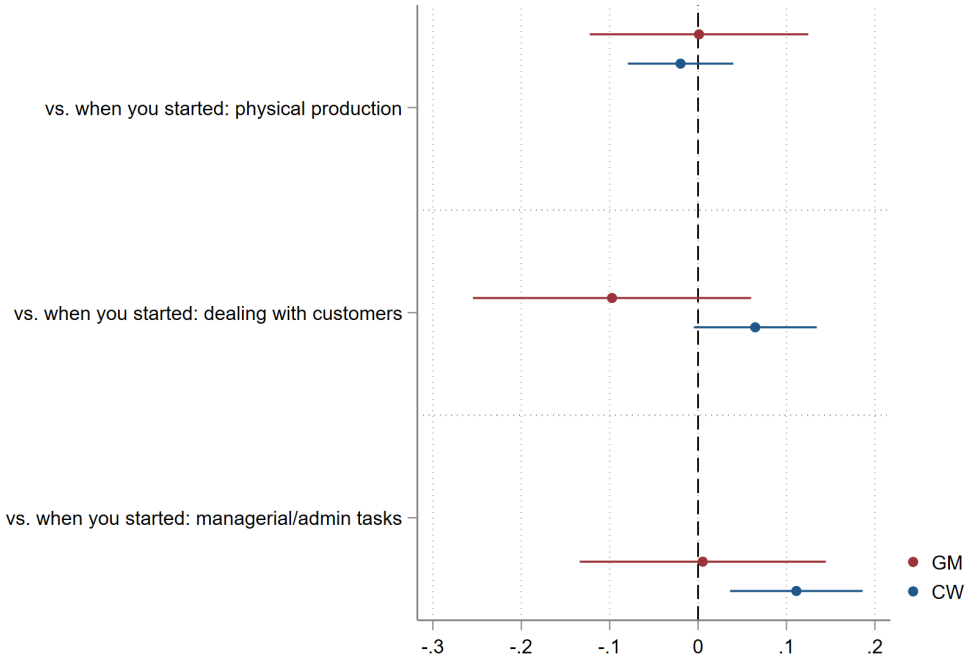


Figure A.4 shows the correlation between employee perceptions of on-the-job skill accumulation in carpentry/metal fabrication (blue dot) and grain milling (red dot) and firm size. Employees were asked to report how skilled they are compared to when they started at the firm in three dimensions: physical production (top), dealing with customers (middle) and other managerial or administrative tasks (bottom). We report coefficients from an OLS regression of a dummy of skill accumulation (= 1 if more skilled in dimension x than when you started, and 0 otherwise) on log firm size, after controlling for a firm's location in the capital city (Kampala). Data is from the follow-up surveys.

B Appendix - Model

C Details about the model

We define the distribution of workers with whom a firm owner matches to be

$$F(z) \equiv \frac{1}{\sum_r \sum_s \int G_w(z,r,s)dz} \sum_r \sum_s G_w(z,r,s)$$

$$\pi(z') = \max_{\{\tilde{\mu},n\}} \mathbb{Z}\left(\tilde{\mu}, n; z'\right)\ n - \overline{w}_m(n-1) - p_m\chi(n) \tag{C.1}$$

s.t.

$$\mathbb{Z}\left(\tilde{\mu}, n; z'\right) = \frac{1}{n}\left(\tilde{y}(\tilde{\mu}; z') + (n-1)\int_z \tilde{y}(\tilde{\mu}; z)dF(z) - \left[c(\varphi(\tilde{\mu}; z')) + (n-1)\int_z c(\varphi(\tilde{\mu}; z))dF(z)\right]\right)$$

$$\tilde{y}(\tilde{\mu}; z) = \left[z'\mu(z,z') + (n-1)\int_z z''\mu(z,z'')dz''\right]$$

$$\varphi(\tilde{\mu}; z) = (1 - \mu(z,z))$$

and $\forall\ z \in \{z' \cup \mathcal{Z}_w\}$

$$D \ \leq\ \mu(z,z') + N\int_{z''} \mu(z,z'')dF(z'')$$

$$1 \ \geq\ \theta(z) \equiv \mu(z',z) + N\int_{z''} \mu(z'',z)dF(z'')$$