Obstacles to Business, Technology Use, and Firms with Female Principal Owners in Kenya

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Abstract

Data on 778 establishments indicates that firms in Kenya rely on technologies such as computers, generators, and cell-phones to conduct operations when regulations, infrastructure, security, workforce, corruption, and finance pose significant hurdles in the business environment. Obstacles related to regulations, security, and workforce, increase the probability of technology ownership, whereas obstacles related to infrastructure in particular, reduces the probability that firms own technology. Results indicate that while all firms rely on technology in the face of regulatory and other obstacles, those with female principal owners experience net effects that are statistically distinct from those experienced by their counterparts. A gender-of-owner disaggregated Oaxaca-Blinder type decomposition of differences in technology ownership indicates that up to 18% of the total gap is unexplained by differences in measurable characteristics between firms that are female-owned and those that are not, suggesting that female-owned firms may own technology to a higher level than is warranted by their observed covariates.

Keywords: Obstacles to Business, Technology, Kenya, Firms, Female Owners
JEL Classification Codes: O14, O12, L14, O55

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Section I: Introduction

It is well-recognized that firms in Africa face large operation costs due to regulatory obstacles to business operations and inadequate infrastructure capabilities. These capabilities include direct measures such as access to telephone land-lines, electricity and water connections, as well as indirect measures such as secure, uncorrupt environments within which to engage in every-day activities, or the availability of adequate finance and an educated, skilled workforce. When hurdles of this nature exist, firms may rely on technology to overcome many of the difficulties faced. For example, if there are significant delays in obtaining mainline telephone connections, firms may opt to rely on technologies such as cell-phones and computers to conduct business, and use email and the internet for communication and advertisement purposes. When the supply of electricity is unreliable, firms may invest in generators to overcome the problem. Furthermore, if crime is rampant, firms may have to pay for security and security equipment to protect their businesses. These examples indicate that the use of technologies such as cell-phones, computers, generators, may be endogenous to regulatory obstacles, poor infrastructure, and an insecure business environment. This is the main hypothesis that is tested in this analysis.

In dealing with the constraints presented by excessive regulation and lack of infrastructure and services, it may be argued that firms owned by women are at an even greater disadvantage. This is because women-owned businesses tend to be more credit-constrained that those run by men. Moreover, unlike firms operated by men, women-owned businesses are often isolated from formal and informal networks that provide information and support. Women-run businesses also tend to be more small-scale. For these reasons, giving gifts or making informal payments to expedite licenses for telephone land-lines or electricity connections, pose a greater hardship for them. Since women-owned firms face higher implicit and explicit costs of operation, intuitively, one would expect different patterns in their reliance on technology such as computers, cell-phones, and generators, as compared to businesses owned by men only. This is a secondary hypothesis tested in this analysis, and the aim of our study is to shed light on these hypotheses using data on firms from Kenya.

Kenya constitutes an interesting environment to study the dependence on technology use by men-owned and women-owned businesses. Like other African countries, Kenyan infrastructure is poorly developed and firms face a plethora of regulatory obstacles related to business and licensing permits, access to land, telecommunications, zoning restrictions, and regulations on pricing and hours of operation. However, unlike other African countries, a sizeable proportion of firms list one or more women as principle owners. Furthermore, as is well known, cell-phone usage is widespread in the country (Aker and Mbiti, 2010). Using the World Bank's Enterprise Survey data on Kenyan manufacturing firms, retail firms, Information and Technology (IT) firms, and micro-enterprises, this study descriptively analyzes whether businesses in general, and particularly those that list a woman as one of the principle owners, rely on technologies such as cell-phones, computers, and generators to circumvent problems arising from inadequately developed infrastructure, an insecure corrupt environment, and excessively stringent laws.

Conditioning on covariates such as regional indicators, firm and industry characteristics which include age of the enterprise, number of permanent and temporary workers, and value of property and machinery, as well as characteristics of the top manager including educational level and experience, this study shows that conditional on obstacles to business, firms in Kenya are more likely to own communication and other technologies such as those noted above. In particular, the probability of technology ownership is 0.07 higher for all firms in the full sample, and 0.01 higher for firms in industries with low barriers to entry for women, if regulations are a moderate, major, or very severe constraint. Although all firms rely on technology when obstacles to business operations are present, we find that Kenyan firms with female ownership exhibit statistically different trends as compared to their male-only owned counterparts. In particular, conditional on firm, industry, and top manager characteristics, the probability of owning a computer, generator, or cell-phone, increases by 0.15 in the full sample of industries if the firm has one or more female principal owners. Tests for the joint significance of the interactions of female-owned firm indicator variable with different obstacle categories emphasize that differential patterns exist in the manner in which female-owned firms react to regulatory hurdles in the manufacturing, retail, and service sectors of Kenya.

In order to explain the distinct pattern in the reliance on technology by female-owned firms, we implement an Oaxaca-Blinder type decomposition procedure. Results from this decomposition show that up to 18% of the total observed gap in use of technology between firms with female owners and those without is unexplained by differences in measurable characteristics. Hence there is some indication that female-owned firms rely relatively more on technology, conditional on firm, industry, and top manager characteristics, as compared to firms that are only male-owned. This behavior is interpreted as being reflective of the widespread understanding in developing countries that female-owned firms are more vulnerable than their male-owned counterparts.

Section 2: Literature Review

Existing studies of the influence of regulatory obstacles on technology adoption have mainly focused on developed countries and have been theoretical in nature. For example, Acemoglu and Autor (2010) argue for changes in the standard model for studying skills and trends in earnings inequality in order to account for the fact that there has been an increase in the use of technologies to substitute capital for low-skilled labor in the United States and other developed countries, and thus, the evolution of technology should be treated endogenously. Alesina and Zeira (2009) note that stringent labor market policies may be responsible for the relative increased reliance on machines to complete low skilled jobs in Europe, as compared to the United States. Acemoglu *et al*. (2007) models technology adoption endogenously particularly when regulations govern relations between a firm and its suppliers.

In terms of the developing world, most studies have concentrated on the adverse economic impacts of restrictive labor legislations. These studies that note the negative relationship between labor regulations and economic impacts include Almeida and Carneiro (2009), which finds that stricter labor laws restrict firm size and the use of informal labor in Brazil. Using data from India, Lall and Mengistae (2005) find that labor laws combined with power shortages are significant determinants of city-level productivity differences. Menon and Sanyal (2005) notes that Indian states with "pro-worker" laws are less likely to attract new domestic investment or new foreign direct investment (Menon and Sanyal, 2007). Finally, Besley and Burgess (2004) finds that restrictive labor laws in India are correlated with

reductions in employment and productivity, particularly in the registered manufacturing sector. These studies mainly focus on the negative economic consequences of labor regulations (only). None consider that technology adoption decisions may be endogenous in environments where regulations exist.

The exception that has noted and tested for the endogeneity of technology adoption in developing countries is Amin (2009). This study uses enterprise-level data from India and finds that retail stores respond to the cost of stricter labor laws by substituting away from workers to computers. Hence labor regulations and technology are endogenous, so that when labor regulations are more stringent, retail stores are more likely to own a computer. This firm behavior reduces dependence on additional workers, which may be expensive when states enforce a host of wage and hour laws and other regulations on working conditions. However, the focus of this study is labor laws only - even though there are robustness checks with respect to some of the other obstacles that a firm may face, these hinge on the assumption that the non-labor obstacles are negatively correlated with computer usage. As we show below, this assumption need not hold. Moreover, Amin (2009) treats ownership of a generator and financial indicators for the firm (whether firms have a checking or savings account, or an overdraft facility) as exogenous, when this is unlikely to be the case. In particular, firms are more likely to own generators when they report that availability of electricity is an obstacle to every-day operations, and state-level laws governing employer-employee relations are likely to be correlated with the ease with which firms obtain lines of credit and overdraft facilities.

This research contributes to the literature in several ways. First, it considers all the obstacles that a firm reports as being impediments to every-day operations, not those related to labor regulations alone. That this is important for obtaining unbiased estimates is clear from a simple correlation exercise which indicates that many of the regulatory and infrastructural obstacles in a firm's business environment are correlated at the 95% or higher level.[1] Second, it considers three different forms of technology that may respond to the stringency of regulations and dearth of infrastructure that exist in a firm's business environment – computers, generators, and cell-phones. Third, it disaggregates technology adoption effects by gender-of-owner, and shows that firms that have female principal owners respond to obstacles

in statistically significant ways that are different as compared to their counterparts. Finally, to the best of our knowledge, it is the first to document the endogeneity of technology adoption in the face of regulatory and other business obstacles in Africa.

Section 3: Business Environment

We begin our analysis by describing the business landscape in Kenya. Table 1 provides a snap-shot of some of the measures constructed by the World Bank using the Enterprise Survey Data for Kenya from 2007. In general, Kenya is a difficult business climate given a variety of regulatory, corruption, crime, and infrastructure-related problems. Among regulatory, corruption, and crime-related indicators, Kenya is worse than the regional average in the number of days required to obtain an import license, the percent of firms indentifying tax rates and tax administration as a major constraint, and the percent of firms identifying business licensing and permits as a major constraint. At 79%, the proportion of firms expected to make informal payments to public officials is more than twice the average for other countries in the same region of Sub-Saharan Africa. Corruption appears to be major problem in public dealings as well as seen by the fact that up to 71% of firms are expected to give gifts in order to secure a government contract, which is again, close to twice the regional average. About one third of all firms identify crime, theft, and disorder as a major obstacle in Kenya.

In terms of infrastructure-related constraints, although Kenya ranks more favorably than the regional average in terms of the number of power outages in a typical month, the proportion of sales lost due to such outages is slightly higher than the regional average proportion. Moreover, although the number of days required in order to obtain a water connection or a mainline telephone connection in Kenya is marginally fewer than the mean number of days for other countries in Sub-Saharan Africa, the number of days required to obtain an electrical connection in Kenya is almost 10 days more as compared to the regional average.

The finance indicators show that Kenya compares more favorably than the regional average in terms of the proportion of firms with credit from financial institutions, and the value of collateral required for a loan. However, such averages mask important differences in access to finance as is clear from

International Finance Corporation (2006). This report shows that women entrepreneurs consider access to finance as one of the biggest obstacles they face. The lack of adequate finance arises primarily from the fact that women have unequal access to land and property in Kenya, and are thus unable to provide collateral in order to secure loans from formal institutions. This restricted access to credit has several consequences including the fact that women-owned businesses are often unable to expand and are compelled to remain at a microenterprise level.

Finally, the trade-related indicators in Table 1 shows that the percent of firms that trade which identify customs and trade regulations as a major constraint is about 4% higher than the regional average. Although this is already unfavorable, there are further differences that disproportionately affect women-owned firms in Kenya. Women entrepreneurs in Kenya are one and half times more likely to cite customs and trade regulations as a barrier as compared to male entrepreneurs (World Bank, 2006).

The regulatory, corruption, crime, infrastructure, finance and trade-related indicators discussed above show that in general, the business ethos in Kenya is more difficult as compared to other countries in the region. In such an environment, it is logical to hypothesize that firms will rely on technologies such as computers, cell-phones and generators, to overcome the costs imposed by constrictive regulations and poor infrastructure. Given their small size, restricted access to finance, and relative isolation from business networks, firms with female owners should be expected to rely on such technologies to an even greater extent as compared to firms with only male owners. We test for these patterns below.

Section 4: Data and descriptive statistics

Data used in this research are from the Enterprise Survey which was implemented by the World Bank in Kenya in 2007. The Enterprise Survey is a firm-level survey which is representative of a country's private sector economy.[2] In Kenya, the firms that were targeted were located in the capital city of Nairobi which is in the central part of the country, the coastal city of Mombasa, Nakuru in the Rift Valley, and Kisumu which is located near Lake Victoria in the Western region of the country (see Map). Establishments in all manufacturing sectors, construction, retail and wholesale services, hotels and restaurants, transport, storage, and communications, and computer and related activities were

administered the survey. Those that had five or more full-time permanent paid employees were stratified into five groups: manufacturing (food and beverages), manufacturing (garment), manufacturing (other), retail trade, and "rest of the universe" (RoU) which included construction, wholesale trade, hotels, bars and restaurants, transportation, storage, and communications, and computer related activities. Firms having fewer than five full-time permanent paid employees ("micro establishments") were also sampled; however, these were not stratified according to industry. The data contain 466 firms from Nairobi, 107 firms from Mombasa, 102 firms from Nakuru, and 106 firms from Kisumu, for a total of 781 firms. Of these, 657 firms employ five or more full-time permanent paid employees and 124 are micro establishments.

The Enterprise Survey asks detailed questions on the environment faced by firms in conducting business within their region of operation. These questions include those related to firm characteristics, gender participation, sales, costs of inputs, workforce composition, bribery payments made, and obstacles related to telecommunications, crime, licensing, infrastructure, trade, competition, land and permits, taxation, access to finance, zoning restrictions, and other restrictions on hours of operation and pricing and mark-ups. Given the sensitive nature of some of the questions, the World Bank contracted with private organizations within the country to conduct the survey. Questions are asked of owners and top managers, although sometimes company accountants and human resource managers are called into the interview, particularly to answer questions on sales and labor-related aspects of the questionnaire. Given the level of detail in the survey, these data are particularly relevant for purposes of this study.

The sampling methodology employed is stratified random sampling with replacement, where the strata are firm size (number of employees), business sector (manufacturing, retail, and other services), and geographic region within the country. Nairobi, Mombasa, Nakuru, and Kisumu were selected since they collectively contain the largest share of economic activity in Kenya. All estimations as well as summary statistics are adjusted with sampling weights provided in the data to account for the differing probabilities of selection across the various strata. We obtain population estimates by applying the sampling weights to individual firm-level observations.

Among the total universe of 781 firms, 778 report information on whether any of the principal owners is female. In these data, 286 firms (36.76%) have one or more female principal owners. The largest proportion of firms with female principal owners is located in manufacturing garment industries (52.17%), followed by retail industries (43.48%) and manufacturing food industries (38.94%). That firms with female principal owners are relatively high in manufacturing garment and retail industries is fairly typical of most developing countries in Africa and Asia. Figure 1 depicts the percentage of firms with female principal owners and those without, by number of employees (firm size). The figure is arranged such that classifications that have the largest difference between female-owned and male-owned firms appear first. Firms are denoted as "small" if they employ 5-19 full-time permanent paid workers, "medium" if they employ 20-99 full-time permanent paid workers and "large" if they employ 100 or more full-time permanent paid workers.[3] As discussed above "micro" firms have fewer than 5 full-time permanent paid workers. From Figure 1 it is clear that firms with female principal owners dominate those with only male owners among the small and micro categories. About 44% of firms with female principal owners are small firms, and about 17% of them are micro firms. Although their presence is still sizeable among medium and large firms, they do not exceed the proportion of male-owned firms within these groupings.

Figure 2 shows the percentage of firms with female principal owners and without, by detailed industrial classification. Again, the figure is arranged to depict the industries with the largest gender-of-owner differences (female-owned – male-owned) first. Firms with female headship are especially high in manufacturing industries that include garments (17%), food (15%), and textiles (5%), in retail industries (25%), and in other industries such as hotels and restaurants (9%) and construction and transport (3%). Figure 2 also reveals that firms with female headship exceed those with male-only headship in manufacturing non-metallic minerals. These non-metallic minerals include gemstones and gold, which is mainly processed by small-scale artisanal workers in the Western and South-Western regions of the country near Lake Victoria.

Figure 3 is a disaggregation of ownership by gender and legal status, and follows the pattern in the figures above by showing those classifications with the largest gap between female and male headship first. Firms are classified as "public" if shares are traded publicly in the stock market. If shares are not traded or traded only privately, the firm is categorized as "private". "Sole proprietorships" and "partnerships" are classes in which ownership participation is not on the basis of shares. More specifically, sole proprietorships are businesses that are owned and managed by an individual, whereas partnerships are firms in which two or more parties share profits and liabilities. The main characteristic of this classification is that each partner has unlimited liability. The "other" category includes some combination of the above four groups, for example, cooperatives or mixed ownership. From Figure 4, it is evident that firms with female ownership exceed those with male ownership among establishments that are registered partnerships, in the other grouping, and, surprisingly, among firms that are legally classified as public. About 21% of firms with female owners are partnerships, 1% is other firms, and another 1% is public firms. The finding that firms with female ownership exceed those with male-only ownership in the public category may reflect the implicit widely held belief that politically connected male owners find it beneficial to include women (often wives) as owners in order to avail of tax and other financial benefits (for example, the "Mwamba" loans that are provided to large businesses for acquiring machinery and other assets by the Kenya Women's Finance Trust (KWFT), Ltd. can be accessed only by women business owners). Figure 4 also shows that firms with female owners are present among sole proprietorships (36%) and private firms (41%); however, their proportions are smaller compared to male-owned firms within these categories.

Finally, figure 4 shows the breakdown of firms by gender-of-owner and use of technology. The technologies considered are computer (the firm uses email or has its own web-site or has an internet connection), generator (the firm owns or shares a generator), and cell-phone (the firm uses cell-phones for communication with clients and suppliers). As noted above, about one-third of firms in these data have one or more female principal owners. In such an environment, it is remarkable to note that firms with female owners rely on computers and cell-phones to such a disproportionately large extent. Figure 4

reports that the percentage of cell-phone ownership by female-owned firms exceeds that of male-owned firms. Approximately 17% of female owned firms use cell-phones compared to about 15 percent of male firms. 49% of female-owned firms rely on computers as compared to 53% of male-owned firms, and the difference between these categories of firms in generator ownership is larger (27% of female-owned firms versus 36% of male-owned firms). The "technology" denoted bars in Figure 4 report the gender disaggregated ownership pattern for computer, generator, and cell-phone combined. It is clear that in terms of usage of these three technologies, the share of firms with female headship is about 68% and the share of firms with male headship is 72%. The patterns in Figure 4 indicate that in comparison to their share in the total population of firms in Kenya, female-owned firms depend on computers, cell-phones, and generators to a relatively high extent as compared to firms with only male-owners.

Figures 1 – 4 provide a graphical description of characteristics of firms with female principal owners in Kenya. Such firms are primarily small with 5-19 full-time permanent paid employees, are mainly present in manufacturing garment and retail industries, are primarily partnerships and cooperatives or classified as mixed ownerships in the other category, and rely on computers and cell-phones to a larger degree than indicated by their presence in the total population of Kenyan firms. Next, we focus on the obstacles perceived by firms in the business environment of Kenya.

The data report constraints related to twenty different types of obstacles. For expositional purposes, the twenty separate types of constraints reported by firms are combined into six categories of obstacles – regulations, infrastructure, security, workforce, corruption, and finance. The regulations group includes the following obstacles: labor regulations, licensing and permits, customs and trade regulations, regulations on hours of operation, regulations on pricing and mark-ups, zoning restrictions, tax rates, and tax administration. The infrastructure group includes obstacles related to telecommunications, electricity, transportation, and access to land. The security category includes constraints related to crime, theft, and disorder, political instability, macroeconomic instability, and functioning of the courts. The workforce group includes obstacles related to an inadequately educated

workforce, and the corruption group includes obstacles related to corruption and practices of competitors in the informal sector. The last group (finance) includes obstacles related to access to finance.

Tables 2A – 2D report unweighted numbers of firms characterizing obstacles as moderate, major, or very severe, by firm size, industry, and technology use. In these data, firms are asked to rank obstacles on a scale of five – no obstacle, minor obstacle, moderate obstacle, major obstacle, and very severe obstacle. The tables that follow report results for firms that describe constraints to be moderate, major, or very severe. It is clear from the total counts in Table 2A that the vast majority of firms report regulations, infrastructure, corruption, and security to be moderate, major, or very severe obstacles, in that order. For firms with female owners, the largest hurdles appear to be regulations, corruption, infrastructure and security. This ranking is about the same for firms with male owners only, except for the switch in places between corruption and infrastructure. Among the six categories of business obstacles, having an inadequately educated workforce appears to be the least constraining for firms in Kenya, although this obstacle still has significant effects on technology ownership as shown below.

Table 2B, which reports a breakdown by firm size of the total numbers in Table 2A, reveals that stringent regulations continues to dominate as a moderate, major, or very severe restriction across both female-owned and male-owned firms. Corruption is an important problem for small firms and access to finance is relatively more difficult for micro firms. Table 2C shows patterns by industry, and regulations continues to be cited as the most binding constraint across manufacturing, retail, information and technology, construction and transport, and hotels and restaurant industries. Lastly, Table 2D reports unweighted counts of obstacles disaggregated by types of technology. In general, firms reporting regulations to be a moderate, major, or very severe constraint are also likely to use email or own a web-site or have an internet connection, use cell-phones to communicate with clients and suppliers, and own or share a generator. This pattern holds true even when firms are differentiated by gender-of-principal owner in this table.

Tables 3A – 3D shows weighted proportions of firms characterizing obstacles as moderate, major, or very severe, by firm size, industry, and technology use. Many of the trends noted above appear

to hold across these tables as well – the one big difference is that access to finance now appears to be a bigger obstacle than was previously evident. Indeed, Table 3A shows that 94.2% of firms report access to finance to be a binding constraint, which is just short of the 99.9% who report regulations to be moderate, major, or a very severe hurdle. Furthermore, estimates in Table 3B reveal that for firms with female owners, access to finance is a relatively steep obstacle for micro and small firms but less so for medium and large firms. Finally, security is a relatively larger concern for medium and large firms across both female-owned and male-owned firms.

Table 3C shows weighted proportions by industrial groupings and for firms with female headship, regulations continue to be the most widely cited obstacle in five of the six industrial categories. Firms with female owners in the construction and transport sector appear to be particularly susceptible to all obstacles considered – the proportion of such firms reporting five of the six constraints to be moderate, major, or very severe uniformly exceeds 97%. This does not appear the case for this industrial sub-group among firms with male owners. Amongst firms with male-ownership, access to finance is in general the most widely cited obstacle after regulations. Finally, estimates in Table 3D show that firms who report using email or own a website or have an internet connection are also more likely to report regulations, security, and infrastructure to be binding obstacles. This is mostly true for cell-phone usage and generator ownership as well, and is still evident when data are disaggregated by gender-of-firm owner.

Tables 2A – 3D provide descriptive evidence that firms perceive excessive regulations, poor infrastructure, lack of security, and widespread corruption as imposing significant burdens in the business environment of Kenya. There are also correlations evident between the perception of these constraints and use of email or own web-sites, cell-phones, and generators. Next, we place structure on these correlations by estimating simple non-linear models that measure the effect of constraints on technology ownership.

Section 5: Business Obstacles and Technology Use

We begin this section by reporting differences in obstacles and other firm level variables between female-headed and male-only headed firms. As noted above, obstacles are coded to represent moderate,

major, or very severe constraints. Furthermore, obstacles measured in the data reflect a firm's perceptions of its operating environment. In order to eliminate possible measurement errors and other endogeneity issues that may contaminate these variables, we take averages of these variables at the region, industry, legal status, and firm size level (Angrist and Krueger 2001). The estimations discussed in the following tables are conducted on constructed mean values of the obstacles rather than an individual firm's perceptions of them.[4]

Table 4 provides weighted descriptive statistics on the characteristics of firms with female owners and those without, and an indication of whether there is a statistical difference in these characteristics. The characteristics reported include ownership of technology (computer, generator, or cell-phone, where establishments are coded as owning a computer if they use email, or have their own web-site, or have an internet connection), obstacles related to regulations, infrastructure, security, workforce, corruption, and finance, regional indicators, firm and industry characteristics including firm size, value of property and machinery, legal status, industrial classification, and whether payments were made for security or for protection or to the police, and finally, characteristics of the firm's top manager including whether she/he has an advanced degree, and her/his number of years of experience in the sector. Estimates in this table indicate that on average, firms with at least one female among principal owners have slightly higher percentage values than firms without female owners in terms of technology ownership.[5] In particular, 99% of female-headed firms own computers, generators, or cell-phones as compared to about 97% of male-owners only firms. However, these numbers are not statistically different.

The reported differences in obstacles for female-headed and male-only headed firms in Table 4 shows that the weighted average percentage value is somewhat higher for female-owned firms in four of the six categories (infrastructure, security, workforce, and corruption); however, these differences are not statistically significant. Table 4 also reports differences in obstacles that might be considered less subjective than those discussed above. These are variables that measure actions that an establishment has actually engaged in and include variables that fall under the broad categories of corruption (payments made for security, protection payments, and payments made informally to the police) and access to

finance (proportion of working capital financed from formal and informal sources). Among these, there is a statistically discernible difference by gender-of-owner in payments made for protection. Estimates indicate that establishments with one or more female principal owners are about 13% more likely to make such payments to organized crime in order to prevent violence.

Differences in regional dummies indicates that there are relatively fewer female-headed firms in Nairobi, and relatively more firms with female owner in Mombasa and Nakuru - these differences are statistically significant. In terms of firm and industry characteristics, although female-owned firms have more years of operation, slightly more full-time employees, lower property values, about the same value of percentage of establishment owned by largest shareholders, relatively fewer proportion of African-origin and Lebanese or Middle Eastern or other Asian or European origin principal owners, the difference is measured precisely only in the case of property values. Another instance in which there is a measurable difference between female and male-owned firms is in terms of manufacturing industries that exclude garments and food. Results in Table 4 indicate that in other manufacturing industries such as chemicals, machinery and equipment, metal and metal products, firms with female principal owners are 24% lower than firms without female principal owners. Lastly, in terms of the top manager characteristics, female-owned firms have managers who are relatively better educated but with slightly lower experience, as compared to male-owned firms; however, these differences are not measured precisely.

Results in Table 4 indicate that firms with female owners are not very different from firms with all-male owners in levels of technology chosen, or in terms of many of the firm, industry, and top manager characteristics considered. While this lack of difference between firms with female principal owners and those without is re-assuring for the estimations that involve the female-owned firm indicator and its interactions, it also points to the possibility that the women-owned firms in the sample may not be representative of the average women-owned firms in the economy. Indeed, these data are less useful to address questions on access to entrepreneurship as it includes a random sample of firms that have overcome barriers to entry and have "survived" to remain in existence. Although this is an issue that

plagues any data set that samples from the private sector of a developing economy, it is less problematic for purposes of this study since the objective is to study reliance on technology in the face of business constraints, conditional on a firm's existence. In fact, given the lack of differences between female-owned and male-owned firms' characteristics in Table 4, we are more confident that the measured difference in technology adoption in response to business obstacles does not arise solely from consistent differences in measurable covariates between these types of firms. Moreover, in order to address the issue of comparability of results with those for the average woman-owned firms in the economy, we estimate our models separately for those industries in which barriers to entry for firms with female-headship are conceivably lower. These include manufacturing industries such as garments, food, textiles, and non-metallic minerals, retail industries, and service industries such as hotels and restaurants, and construction and transport – the industries in Figure 2 where the presence of firms with female owners exceeds that of firms with only-male owners. In this sub-set of industries, there are 502 firm-level observations, of which 215 have female principal owners and 287 have only male principal owners. The tables that follow present two sets of results – effects for firm in all industries, and separate effects for firms in industries with low barriers to entry for female-headed firms.

Marginal effects for technology ownership

Results for technology ownership, where establishments are coded as owning technology if they report owning a computer, generator, or cell-phone, are reported in Table 5A. The first column of Table 5A shows marginal effects from a probit model that includes only obstacles to everyday operations of the firm. The table reports results for the six different categories of obstacles defined above. The second column shows marginal effects from a probit model that includes obstacles, and an indicator variable for whether the establishment has one or more female principal owners, the third column reports results for the variables in the second column along with the interactions of the female ownership variable with the different obstacle categories. The fourth column builds on the results in the third column by adding regional indicators, firm and industry characteristics (firm's age, controls for property and machinery value, the number of permanent and temporary employees, and industrial classification), and

characteristics of the firm's top manager (indicator variable for having an advanced degree and experience in the sector). Regressions are weighted to be representative of the national population of firms using weights provided by the Enterprise Survey data for Kenya.

The first column of Table 5A shows that of the various categories of obstacles, regulations, infrastructure, workforce, and finance are significant. Estimates indicate that if regulations are a moderate, major or very severe obstacle, the probability of owning technology is 0.19 higher. Since regulations includes obstacles such as labor regulations, licensing and permits, regulations on hours and pricing as well as zoning restrictions, this is consistent with the hypothesis that technology is endogenous when rules and restriction are excessively binding on firms. For labor regulations in particular, this result is consistent with the labor-saving function of computers, and in keeping with studies that have found that where labor regulations are binding, firms are more likely to invest in computers (Amin 2009). The other obstacles that increase technology ownership include workforce and finance. The fact that inadequately educated workforce is positively correlated with technology ownership is interesting because it indicates that when such regulations pose an obstacle, firms use technology to overcome this hurdle. This substitution of capital (technology) for low-skilled labor (inadequately educated workforce) is broadly consistent with Acemoglu and Autor (2010) and Alesina and Zeira (2006). Moreover, inadequate access to finance, perhaps as reflected in a restricted access to fixed capital for purposes of expansion, also significantly influences firms to rely on technology. In terms of a negative effect, the obstacle that lowers the probability of technology ownership is infrastructure. This is as expected since this category includes electricity, in the absence of which technology ownership becomes difficult.

The second column of Table 5A shows that conditional on obstacles, firms with one or more female principal owners are more likely to own technologies such as computers, generators, and cell-phones. For such firms, the probability of technology ownership is higher by 0.02. Column (3) of Table 5A reports results for the interaction terms of female headship and the different obstacles in column (1). Note that if there were no differentiated impacts by gender of principal owners, the interactions terms should not be significant. This is not the case as evident from column (3), where four of the six

interaction terms are significant. In particular, whereas regulations have a positive effect on technology ownership for all firms, those with female principal owners experience a lower 0.34 probability of owning technology when regulations are binding. Estimates in column (3) indicate that for firms with female headship, the probability of technology ownership is only larger by 0.03 when regulations are an obstacle. The positive sign is consistent with our hypothesis outlined above, but the smaller relative magnitude for technology ownership in such firms is unexpected. One part of the explanation may rest of the fact that technology requires access to finance, and female-firms are more likely to be financially constrained as compared to male-headed firms as noted above.

Other interaction terms that are significant in column (3) include infrastructure and security. The net effect for infrastructure indicates that the probability of technology ownership for female-owned firms is higher when such obstacles are binding. Since this category subsumes telecommunications, transport, and access to land, this is as expected. In particular, when access to land is a major obstacle, firms with female headship are on average, more likely to own technology such as computers. This is consistent with the fact that where it is difficult to expand the size of the business because of such constraints, such firms may substitute computers for workers in order to increase work capacity without increasing physical work-space. The interaction term on security is significant as well and is consistent with female firms relying more on computers to accomplish tasks when crime and theft is pervasive or when there is political instability. Firms may overcome disruptions to business operations caused by instability by relying on computers to maintain day-to-day activities. For example, if curfews are imposed to limit mobility during times of unrest, female-headed firms may use email and cell-phones to contact suppliers and other partners in business. Moreover, results in the third column of Table 5A show that probability of technology ownership is lower for female-headed firms that cite corruption to be a binding constraint. This category includes practices of competitors in the informal sector where such practices may include favors that are extended to individuals in certain social networks, over and above bribes and informal payments that are made to expedite the purchase and sale of goods and services. The negative coefficient

on the corruption interaction term may indicate the relative isolation of female firms from business networks, if membership in social networks expedites technology ownership.

Continuing the discussion of results in column (3) of Table 5A, the indicator variable for whether the establishment has one or more female principal owners is significant in this indicating that such firms are more likely to own computers as compared to others that have only male principal owners. The estimate indicates that the probability of technology ownership is 0.82 higher for establishments that are female-owned. This, along with the other gender-of-owner differentiated effects in column (3), are a clear indication that while all firms rely on computers to circumvent obstacles that exist in their operating environments, this is especially true for female-headed firms. Effects of hurdles particular to only female-owned firms are also consistent with the more general observation that in developing countries, female-headed firms are more vulnerable as compared to their counterparts. A test of the terms representing interactions of the obstacles with the indicator of female-headship indicates that the null hypothesis that these effects are jointly zero can be rejected; that is, these female interaction terms are statistically significant in the model.

Column (4) includes regional, firm, and top manager characteristics to the variables in column (3) of Table 5A. As is clear, regulations and infrastructure continue to exert significant effects on technology ownership for all firms, and regulations and infrastructure continue to net effects on firms that are female-headed. With the inclusion of firm and industry covariates, the indicator variable for firms with female principal owners decreases in magnitude. The coefficient for this variable in column (4) indicates that the probability of technology ownership is 0.15 higher for firm with female-owners, conditional on obstacles and regional, firm, industry, and top manager characteristics. Again, a test of the terms representing interactions of the obstacles with the indicator of female-headship indicates that the null hypothesis that these effects are jointly zero can be rejected; that is, these female interaction terms are statistically significant in the regression.

Table 5B repeats the models in Table 5A for industries where barriers to entry are relatively low for women. We focus our discussion on the third and fourth columns of this table since these include the

interaction terms and the full set of regressors, and compare results with the corresponding columns of Table 5A. A comparison of estimates in the third columns of Table 5A and 5B show that regulations, infrastructure, and finance continue to have significant effects, although the magnitude of these effects is somewhat lower for the first two categories of obstacles. The interaction term on infrastructure continues to exert a positive but smaller effect on technology ownership, and the indicator for firms with female principal owners remains positive and significant, but again, is of smaller magnitude. The joint test of significance on the interaction terms reported at the bottom of Table 5B continues to confirm that the interaction terms are not jointly zero, but the p-value is higher than in the corresponding column of Table 5A. A comparison of results in the fourth columns is similar to the comparison of results in the third columns of these two tables, except that the indicator variable loses significance and the joint test can no longer reject that the female-firm interaction terms are insignificant.

The comparison of results in Tables 5A and 5B underscores the fact that some of the gender-differentiated technology effects in the first table arise from the fact that the female-owned firms in the sample, although comparable to the male-owned firms, are perhaps not comparable to the average female-firm in the economy. However, two points are noteworthy in the results of Table 5B which contains female-owned firms that are representative of the larger underlying economy – first, gender-of-owner disaggregated effects are evident and statistically jointly significant in column (3), and second, consistent with the main hypothesis of this study, all firms rely more on the ownership of technologies such as computers, generators, and cell-phones, when regulations, infrastructure, security, and corruption, pose significant hurdles, and female-owned firms appear to be particularly responsive to infrastructure related constraints.

The models in Tables 5A and 5B include average measures of obstacles. As noted above, we take averages in order to avoid bias that may result from measurement errors and other sources of endogeneity specific to a firm or the survey's respondent (subjective responses). An alternative method is to use more objective measures of obstacles – that is, actual measures of activities that the firm has had to engage in. These include indicators of corruption such as whether the establishment made protection

payments to organized crime to prevent violence, paid for security (equipment, personnel, or security services), or made informal payments to the police when transporting goods, and (actual) indicators of access to finance such as the average percent of working capital financed from formal sources (banks, non-bank financial institutions, and credit) and informal sources (family and moneylenders). As discussed in Bardasi *et al*. (2007), corruption and access to finance are two obstacles in which all firms, especially female-owned ones, are considered to be particularly disadvantaged. Results for technology ownership for these objective measures of corruption are reported in Tables 5C and 5D. In keeping with the structure above, Table 5C reports results for all industries and Table 5D reports results for those industries with low barriers to entry for female-owned firms.

The first column of Table 5C shows that paying for security, making informal payments to the police, and the ability to finance working capital for formal and informal sources, have significant effects on technology ownership. Moreover, the gender-of-owner interaction terms for measures of access to finance are significant and jointly different from zero. Column (2) of Table 5C excludes the variable that measures payments to police as it was asked mainly for manufacturing firms. This exclusion increases the number of firm level observations in column (2), and now, the indicator variable for firms with female principal owners is significant and shows that the probability of technology ownership is 0.01 higher for these firms, conditional on objective measures of corruption and access to finance obstacles. Results for female-owned firms in industries with fewer barriers to entry (Table 5D) show that protection payments, payments to police, and ability to raise funds from informal sources are significant, and that there are gender of owner disaggregated effects in the case of payments to police. The gender-of-owner disaggregated effects are also evident in the second column of Table 5D, particularly in terms of protection payments and payment for security. Joint tests at the bottom of both columns in Table 5D show that the interaction terms are significantly different from zero. Lastly, a column-by-column comparison of results in Tables 5C and 5D shows that effects particular to payments made to the police is similar in sign but smaller in magnitude, proportion of working capital financed from informal sources

has the same sign but is larger magnitude, and interaction terms specific to variables measuring access to finance obstacles matter less in the smaller subset of industries.

The results in Tables 5C and 5D are broadly consistent with those in Tables 5A and 5B in showing that technology ownership is responsive to business obstacles, whether the latter are measured as averages of subjective perceptions or as more objective measures (actions a firm has engaged in). Furthermore, the results in Tables 5A – 5D reveal that while all firms rely on technology to overcome different obstacles to current operations, those that have female principal owners experience net impacts that are statistically distinct from those experienced by their male-only owned counterparts.

Oaxaca-Blinder type decomposition effects for technology ownership

In this section of the results, we discuss the estimates reported in Tables 6A and 6B. Table 6A shows average predicted probabilities for technology ownership using data from firms with female owners and firms without female owners, and female firm coefficients (coefficients obtained from the full model in column (4) of Table 5A when the data are restricted to firms with female principal owners) and male firm coefficients (coefficients obtained from the full model in column (4) of Table 5A when the data are restricted to firms with only male principal owners). We ask two questions in order to compare the technology ownership behavior of these two categories of firms. First, given the sample of firms with female principal owners, what would technology ownership be if it was decided in the universe of male firms? This question is answered by taking the female firm sample and by predicting technology ownership probabilities using the male firm coefficients. Next, the converse is done for the male firm sample using female firm coefficients. This method is similar to the one employed in Barmby and Smith (2001). The exercise is repeated separately for industries with low barriers to entry for women (the same industries as in Tables 5B and 5D), and the average predicted probabilities for all industries and the smaller sub-set of industries are reported in Table 6A.

The results in Table 6A indicate that predicted technology ownership for female firms using own coefficients is 0.99, while the corresponding number for male firms using own coefficients is 0.97. Hence, on average, female firms rely on technology to a slightly higher degree than male firms. If the

male firms had the same "behavior" as female firms as measured by the estimated coefficients for the female firms, the average probabilities for technology would be 0.99. This probability is higher than the true effect (0.97) for male firms noted above, indicating again that female firms own technology to a somewhat greater extent. Moreover, if the female firms had the behavior of male firms, the average probabilities for computer and technology would fall to 0.97. This is lower than the true effect (0.99) noted above, which further underlines the fact that in comparison to male firms, female firms rely on technology to a slightly greater degree. Furthermore, results in Table 6A shows that restricting the analysis to industries with low barriers to entry for female-owned firms reduces, but does not completely close the gap between true effects for firms with female owners and those without (the gap declines from 0.015 to 0.010). Hence, the small difference in average predicted probabilities is still evident when we consider female-owned firms that are representative of the average female-owned firms in the country.

The difference in technology ownership between female and male firms can be decomposed into a component which is due to differences in sample characteristics (characteristic or explained component) and a component which is due to differences in behavior (preference or residual component). Such a decomposition is comparable to the Oaxaca-Blinder method where observed differences between two groups can be divided into differences in the coefficients estimated and differences in measured characteristics. However, the actual Oaxaca-Blinder decomposition is suitable for linear models only. In this study, we implement a comparable method that can be used when the dependent variable is non-linear (Barmby and Smith, 2001, Sayer *et al*., 2004, Fairlie, 2006). The equation that underlies the Oaxaca-Blinder type method is:

$$T_{mij} - T_{fij} = \beta_m(X_{mij} - X_{fij}) + (\beta_m - \beta_f)X_{fij} \qquad (1)$$

Where T_{mij} and T_{fij} represent average probabilities of technology ownership in the male and female firm samples where the *mij* subscript now denotes male firms in region *j* and the *fij* subscript denotes female firms in region *j*, β_m and β_f are the estimated male and female coefficients discussed above, and X_{mij} and X_{fij} are the male and female firm samples. The first term on the right hand side of the equation represents part of the total gap which is due to differences in observables (explained component) and the second

term is the portion of the total gap that is due to differences in behavior (residual component). As is done in the labor evaluation literature, results of the decomposition are estimated using male coefficients as weights[6]. These results are presented in Table 6B. Again, separate results are presented in this table for the industries with low barriers to entry for women-owned firms.

The negative signs of the magnitudes of the residual component in the first panel of Table 6B reflects the fact that the total observed gap in technology ownership is negative (note that in the equation above, female values are differenced from male values). For technology ownership in the full sample, 124.3% of the total gap is due to the residual component attributed to unobserved factors. In the sub-set of industries in the second panel of Table 6B, 17.6% of the total gap is due to unobserved factors. Although this large difference suggests that in the full sample of industries, firms with female principal owners may be more versatile with technology ownership, note that restricting the sample to representative female-owned firms does not drive the residual component to zero. Estimates in the second panel of Table 6B still indicate that up to 18% of the gap in technology ownership between male and female firms remains unexplained by observed covariates. We interpret this as evidence for the idea that in environments where regulations are excessive, infrastructure is inadequate, corruption is rife, and lack of security is pervasive, female-owned firms own technology to a greater degree than is warranted by their level of measured characteristics. They thus appear to "over-compensate", perhaps in order to counter-act the effects of firm-related, industry-related, or other unobservables that may be present in the environments in which they operate, or to which they are particularly susceptible. This result may also reflect unmeasured vulnerabilities such as exclusion from inadequately developed business and informal networks that provide support and information.

Section 6: Conclusion and implications for policy

Using data on firms in the manufacturing, retail, and service sectors from Kenya, this study shows that ownership of technologies such as computers, generators, and cell-phones increases when regulations, infrastructure, security, workforce, corruption, and finance pose significant burdens to every-day operations in the business environment. In particular, the probability of technology ownership is 0.07

higher for all firms in the full sample, and 0.01 higher for firms in industries with low barriers to entry for women, if regulations are a binding constraint. Such patterns are also true for female-owned firms which tend to be excluded from formal and informal network groups, and are often more credit-constrained than male-only owned firms in developing countries. Estimates indicate that conditional on observables and the full set of industries, the probability of owning a computer, generator, or cell-phone is higher by 0.15 if the firm is female-headed. Interactions of the gender-of-owner indicator variable with different obstacle categories emphasize that differential patterns exist in the manner in which female-owned firms react to regulatory hurdles in Kenya. In order to explain the somewhat greater reliance on technology by female-owned firms in the face of regulatory and infrastructural hurdles, we implement an Oaxaca-Blinder type decomposition procedure which shows that up to 18% of the total observed gap in use of technology between firms with female owners and those without remains unexplained by differences in measurable characteristics.

The results of this analysis provide some evidence that technology ownership is endogenous when regulations are restrictive and infrastructure is weak. Firms rely on computers, generators, and cell-phones to overcome the deficiencies posed by stringent restrictions on hours of operations as well as inadequate telecommunications infrastructure and unreliable power supply in order to conduct every-day activities. The results of this study indicate that in addition to removing regulatory hurdles and improving physical infrastructure, firms may benefit from policies that enable greater technology ownership. A way of implementing this would be to extend access to loans that are relatively low-cost for purposes of purchasing computers, generators, and cell-phones. Since operation of computers, in particular, requires a basic level of skills, the provision of inexpensive vocational training and computer literacy courses would also be of value. Finally, policies that build networks among female-owned businesses would help diffuse know-how on using technology to mitigate regulatory and infrastructural burdens in the business environment of Kenya.

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Political map of Kenya

Source: http://www.nationsonline.org/oneworld/map/kenya_map.htm. Accessed on August 12, 2010.

Figure 1: Percentage of firms with female principal owners and without, by firm size

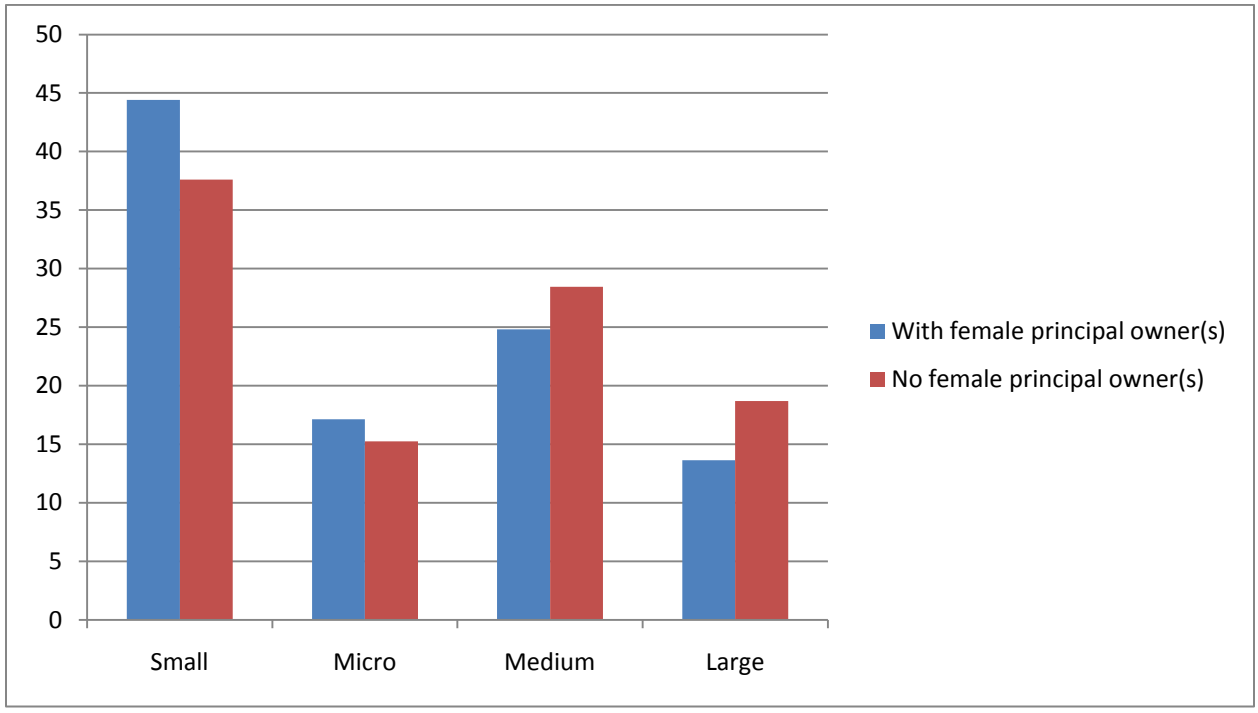

Figure 2: Percentage of firms with female principal owners and without, by industry

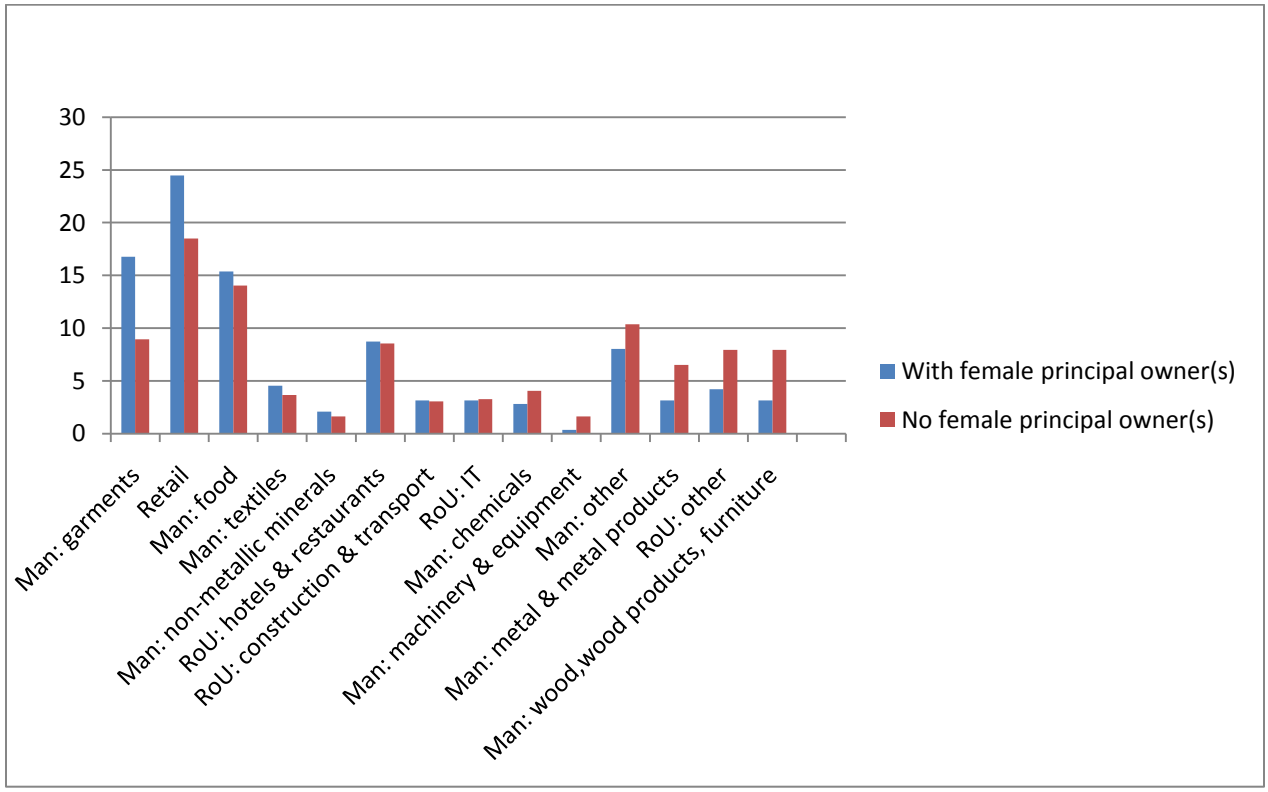

Figure 3: Percentage of firms with female principal owners and without, by legal status

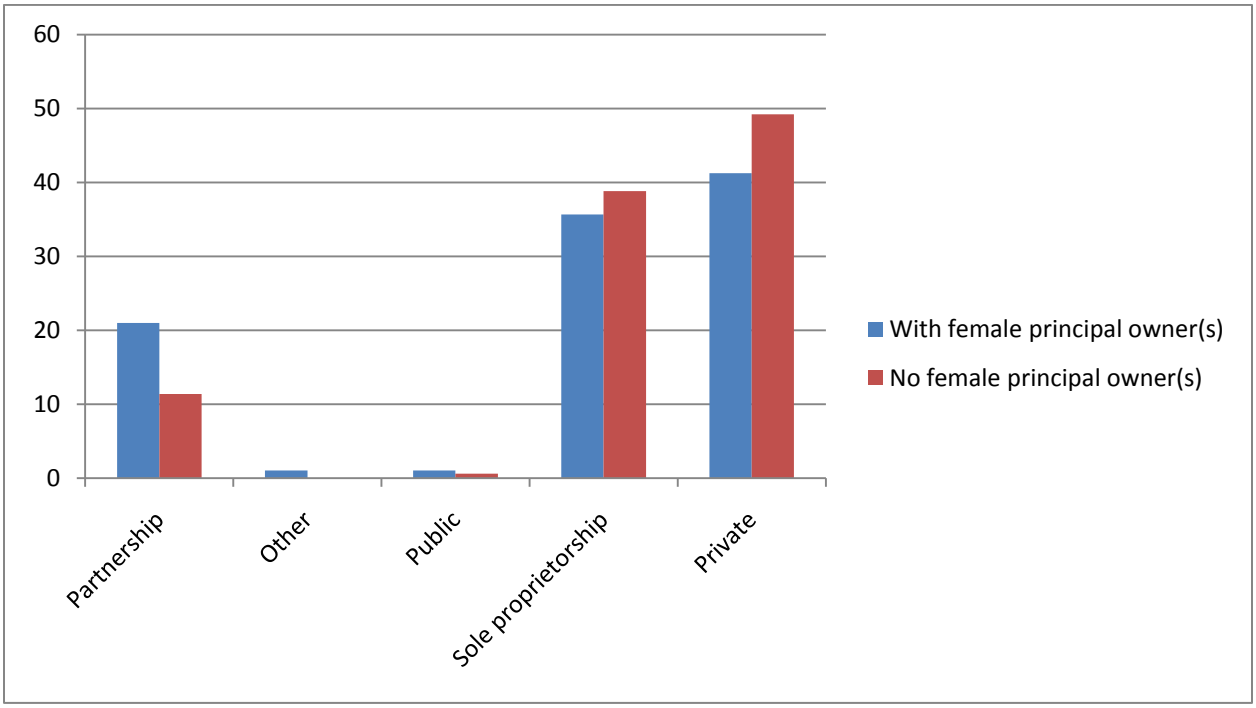

Figure 4: Percentage of firms with female principal owners and without, by technology

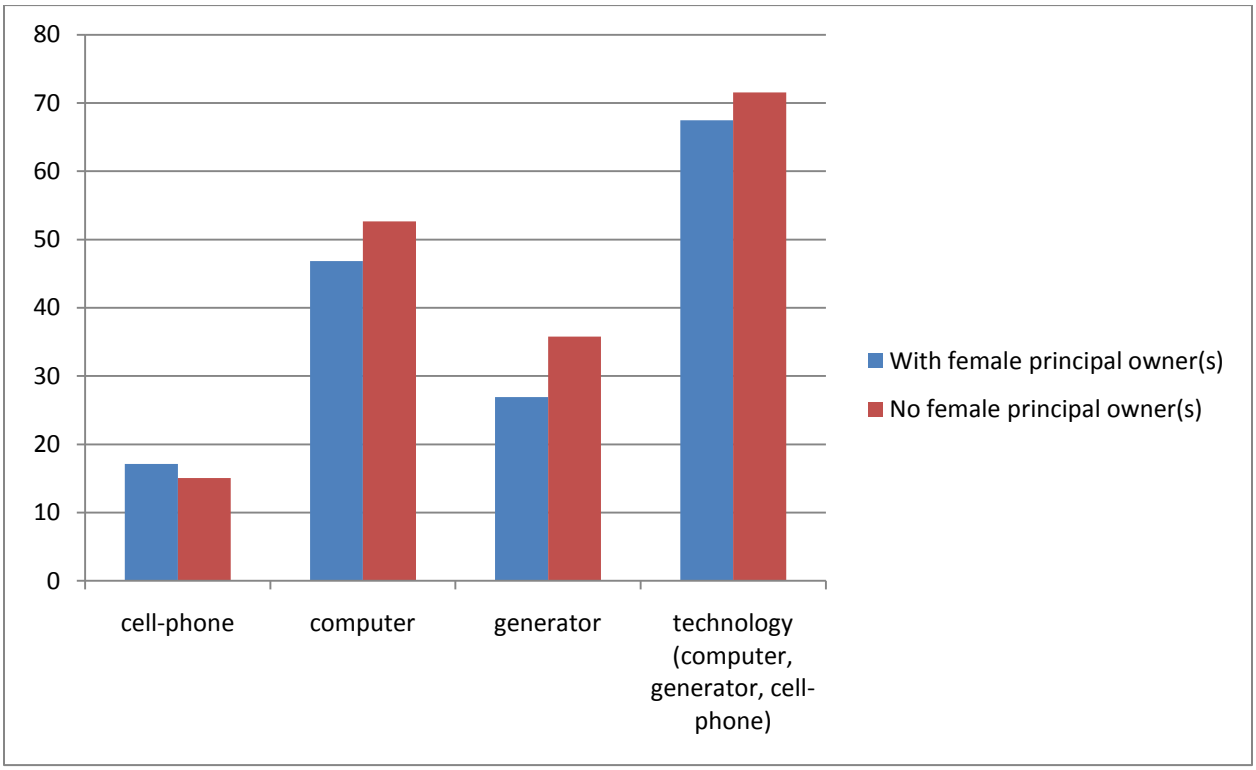

Table 1: Business environment in Kenya

Indicators	Kenya	Mean for Sub-Saharan Africa
Regulatory, Corruption, and Crime-related Indicators		
Days to obtain import license	25.92	19.23
% of firms identifying tax rates as major constraint	58.22	37.99
% of firms identifying tax administration as major constraint	32.00	26.20
% of firms identifying business licensing and permits as major constraint	28.28	15.52
% of firms expected to pay informal payments to public officials (to get things done)	79.22	35.16
% of firms expected to give gifts in order to get an operating license	28.75	19.53
% of firms expected to give gifts in order to secure a government contract	71.20	38.33
% of firms paying for security	74.61	60.45
Losses due to theft, robbery, vandalism, and arson against the firm (% of sales)	3.87	1.68
% of firms identifying crime, theft, and disorder as major constraint	33.09	27.68
Infrastructure-related Indicators		
Number of power outages in a typical month	6.90	10.30
Value lost due to power outages (% of sales)	6.35	5.84
Delay in obtaining an electrical connection (days)	40.50	31.94
Delay in obtaining a water connection (days)	27.97	28.60
Delay in obtaining a mainline telephone connection (days)	27.09	32.73
Finance and trade-related Indicators		
% of firms with line of credit or loans from financial institutions	25.41	21.63
Value of collateral needed for a loan (% of loan amount)	120.81	142.60
% of firms identifying access to finance as a major constraint	41.80	45.64
% of firms that trade identifying customs and trade regulations as a major constraint	23.59	20.11

Source: World Bank, Enterprise Survey Data for Kenya, 2007.

Table 2A: Unweighted numbers of firms characterizing obstacles as moderate, major, or very severe

	Total	**With female principal owners**	**No female principal owners**
Obstacles related to			
regulations	767	279	488
infrastructure	670	242	428
security	617	227	390
workforce	150	57	93
corruption	661	246	415
finance	486	183	303

Notes: There are 778 total firms in the sample of which 286 firms have female principal owners and 492 have only male principal owners.

Table 2B: Unweighted numbers of firms characterizing obstacles as moderate, major, or very severe, by firm size

	With female principal owners				**No female principal owners**			
	Micro	*Small*	*Medium*	*Large*	*Micro*	*Small*	*Medium*	*Large*
Obstacles related to								
regulations	49	123	68	39	75	181	140	92
infrastructure	43	108	57	34	64	154	123	87
security	38	94	61	34	52	124	127	87
workforce	9	17	18	13	9	22	39	23
corruption	39	112	61	34	57	157	121	80
finance	37	93	39	14	68	129	73	33

Notes: There are 778 total firms in the sample of which 124 are micro firms, 312 are small firms, 211 are medium firms, and 131 are large firms.

Table 2C: Unweighted numbers of firms characterizing obstacles as moderate, major, or very severe, by industry

	With female principal owners					
	Manufacturing	*Retail*	*Information & Technology*	*Construction & Transport*	*Hotels & Restaurants*	*Other*
Obstacles related to						
Regulations	161	65	7	9	25	12
Infrastructure	144	56	7	6	21	8
Security	140	49	6	8	16	8
Workforce	43	9	0	0	5	0
Corruption	142	56	8	8	20	12
Finance	100	48	6	4	16	9

	No female principal owners					
	Manufacturing	*Retail*	*Information & Technology*	*Construction & Transport*	*Hotels & Restaurants*	*Other*
Obstacles related to						
Regulations	289	88	15	15	42	39
Infrastructure	266	74	13	13	36	26
Security	253	58	9	13	34	23
Workforce	70	10	1	3	7	2
Corruption	246	67	13	15	40	34
Finance	161	64	9	12	28	29

Notes: There are 778 total firms in the sample of which 450 are in manufacturing firms, 161 are retail firms, 25 are Information and Technology firms, 24 are Construction and Transport firms, 67 are Hotels and Restaurant firms, and 51 are other firms.

Table 2D: Unweighted numbers of firms characterizing obstacles as moderate, major, or very severe, by use of technology

	With female principal owners			**No female principal owners**		
	Firm uses email or its own website or an internet connection	*Firm uses cell-phone for communication with clients and suppliers*	*Firm owns or shares a generator*	*Firm uses email or its own website or an internet connection*	*Firm uses cell-phone for communication with clients and suppliers*	*Firm owns or shares a generator*
Obstacles related to						
Regulations	129	49	77	257	74	176
Infrastructure	112	43	70	232	63	170
Security	116	38	73	231	52	165
Workforce	26	9	28	66	9	48
Corruption	110	39	71	221	56	153
Finance	69	37	40	125	67	82

Notes: There are 778 total firms in the sample of which 393 firms use email or own website or an internet connection, 123 firms use cell-phones for communication with clients and suppliers, and 253 firms own or share a generator.

Table 3A: Weighted proportions of firms characterizing obstacles as moderate, major, or very severe

	Total	**With female principal owners**	**No female principal owners**
Obstacles related to			
regulations	0.999	0.997	1.000
	(0.0005)	(0.002)	(0.00001)
infrastructure	0.868	0.898	0.852
	(0.014)	(0.066)	(0.019)
Security	0.677	0.707	0.661
	(0.106)	(0.132)	(0.087)
workforce	0.144	0.120	0.114
	(0.072)	(0.131)	(0.031)
corruption	0.819	0.829	0.814
	(0.060)	(0.047)	(0.065)
Finance	0.942	0.889	0.971
	(0.021)	(0.067)	(0.007)

Notes: There are 778 total firms in the sample of which 286 firms have female principal owners and 492 have only male principal owners. Weighted to national level with weights provided by the Enterprise Survey of Kenya. Table reports percentage values. Robust standard errors in parenthesis.

Table 3B: Weighted proportions of firms characterizing obstacles as moderate, major, or very severe, by firm size

	With female principal owners				**No female principal owners**			
	Micro	*Small*	*Medium*	*Large*	*Micro*	*Small*	*Medium*	*Large*
Obstacles related to								
regulations	1.000	0.934	0.814	1.000	1.000	0.978	1.000	1.000
	(0.000)	(0.041)	(0.091)	(0.000)	(0.000)	(0.007)	(0.000)	(0.000)
infrastructure	0.904	0.779	0.648	0.714	0.854	0.815	0.726	0.867
	(0.065)	(0.053)	(0.087)	(0.068)	(0.020)	(0.021)	(0.066)	(0.037)
Security	0.706	0.685	0.823	0.715	0.659	0.657	0.831	0.829
	(0.136)	(0.103)	(0.038)	(0.144)	(0.089)	(0.077)	(0.088)	(0.048)
workforce	0.202	0.142	0.072	0.119	0.113	0.113	0.168	0.287
	(0.135)	(0.042)	(0.029)	(0.018)	(0.032)	(0.026)	(0.037)	(0.050)
corruption	0.829	0.839	0.824	0.763	0.813	0.846	0.882	0.858
	(0.048)	(0.055)	(0.063)	(0.065)	(0.067)	(0.031)	(0.017)	(0.010)
Finance	0.898	0.714	0.486	0.219	0.981	0.690	0.530	0.335
	(0.065)	(0.023)	(0.046)	(0.123)	(0.006)	(0.030)	(0.067)	(0.055)

Notes: There are 778 total firms in the sample of which 124 are micro firms, 312 are small firms, 211 are medium firms, and 131 are large firms. Weighted to national level with weights provided by the Enterprise Survey of Kenya. Table reports percentage values. Robust standard errors in parenthesis.

Table 3C: Weighted proportions of firms characterizing obstacles as moderate, major, or very severe, by industry

	With female principal owners					
	Manufacturing	*Retail*	*IT*	*Construction & Transport*	*Hotels & Restaurants*	*Other*
Obstacles related to						
regulations	1.000	0.996	0.667	1.000	1.000	1.000
	(0.000)	(0.003)	(0.088)	(0.000)	(0.000)	(0.000)
infrastructure	0.984	0.926	0.667	0.976	0.994	0.349
	(0.019)	(0.052)	(0.088)	(0.025)	(0.005)	(0.014)
security	0.820	0.640	0.721	0.995	0.714	0.669
	(0.071)	(0.119)	(0.061)	(0.008)	(0.259)	(0.006)
workforce	0.020	0.334	-	-	0.193	-
	(0.016)	(0.187)			(0.130)	
corruption	0.806	0.928	0.834	0.992	0.536	1.000
	(0.068)	(0.052)	(0.044)	(0.013)	(0.126)	(0.000)
finance	0.786	0.923	0.617	0.967	0.987	0.666
	(0.068)	(0.052)	(0.102)	(0.033)	(0.010)	(0.008)

Table 3C (continued): Weighted proportions of firms characterizing obstacles as moderate, major, or very severe, by industry

	No female principal owners					
	Manufacturing	*Retail*	*IT*	*Construction & Transport*	*Hotels & Restaurants*	*Other*
Obstacles related to						
regulations	1.000	0.999	0.996	1.000	1.000	1.000
	(0.000)	(0.0001)	(0.0002)	(0.000)	(0.000)	(0.000)
infrastructure	0.856	0.991	0.973	0.674	0.972	0.658
	(0.052)	(0.005)	(0.011)	(0.009)	(0.012)	(0.052)
security	0.615	0.645	0.940	0.995	0.967	0.605
	(0.110)	(0.095)	(0.034)	(0.008)	(0.010)	(0.134)
workforce	0.131	0.078	0.005	0.328	0.039	0.104
	(0.037)	(0.074)	(0.009)	(0.006)	(0.038)	(0.133)
corruption	0.821	0.774	0.981	1.000	0.993	0.766
	(0.046)	(0.134)	(0.024)	(0.000)	(0.003)	(0.080)
finance	0.989	0.988	0.944	0.989	0.937	0.916
	(0.009)	(0.007)	(0.016)	(0.006)	(0.027)	(0.026)

Notes: There are 778 total firms in the sample of which 450 are in manufacturing firms, 161 are retail firms, 25 are Information and Technology firms, 24 are Construction and Transport firms, 67 are Hotels and Restaurant firms, and 51 are other firms. Weighted to national level with weights provided by the Enterprise Survey of Kenya. Table reports percentage values. Robust standard errors in parenthesis.

Table 3D: Weighted proportion of firms characterizing obstacles as moderate, major, or very severe, by use of technology

	With female principal owners			**No female principal owners**		
	Firm uses email or its own website or an internet connection	*Firm uses cell-phone for communication with clients and suppliers*	*Firm owns or shares a generator*	*Firm uses email or its own website or an internet connection*	*Firm uses cell-phone for communication with clients and suppliers*	*Firm owns or shares a generator*
Obstacles related to						
regulations	0.960	1.000	1.000	0.997	1.000	1.000
	(0.011)	(0.000)	(0.000)	(0.0003)	(0.000)	(0.000)
infrastructure	0.892	0.904	0.968	0.688	0.851	0.977
	(0.024)	(0.065)	(0.037)	(0.013)	(0.019)	(0.017)
security	0.944	0.706	0.981	0.946	0.670	0.966
	(0.013)	(0.136)	(0.022)	(0.036)	(0.086)	(0.023)
workforce	0.031	0.202	0.232	0.301	0.115	0.253
	(0.022)	(0.135)	(0.072)	(0.018)	(0.032)	(0.060)
corruption	0.867	0.829	0.975	0.952	0.810	0.934
	(0.094)	(0.048)	(0.025)	(0.047)	(0.069)	(0.040)
finance	0.145	0.898	0.610	0.888	0.980	0.607
	(0.033)	(0.065)	(0.057)	(0.069)	(0.006)	(0.126)

Notes: There are 778 total firms in the sample of which 393 firms use email or own website or an internet connection, 123 firms use cell-phones for communication with clients and suppliers, and 253 firms own or share a generator. Weighted to national level with weights provided by the Enterprise Survey of Kenya. Table reports percentage values. Robust standard errors in parenthesis.

Table 4: Descriptive statistics disaggregated by gender of principal owner

	Firm has at least one female principal owner	Firm has no female principal owner	Difference (column 1 - column 2)
Endogenous variable			
Firm owns a computer,	0.985	0.968	0.017
generator, or cell-phone	(0.003)	(0.016)	(0.017)
Obstacles related to			
regulations	0.998	0.999	-0.001
	(0.001)	(0.0002)	(0.001)
infrastructure	0.923	0.839	0.084**
	(0.026)	(0.023)	(0.034)
security	0.708	0.660	0.048
	(0.039)	(0.033)	(0.051)
workforce	0.161	0.134	0.027
	(0.035)	(0.024)	(0.043)
corruption	0.791	0.834	-0.043
	(0.031)	(0.019)	(0.037)
finance	0.943	0.941	0.001
	(0.016)	(0.014)	(0.021)
Objective measures of obstacles			
Firm paid for security (equipment,	0.754	0.642	0.112
personnel, or security services	(0.057)	(0.042)	(0.071)
Firm made protection payments (to	0.169	0.043	0.126**
organized crime to prevent violence)	(0.056)	(0.020)	(0.060)
Firm made informal payments to the	0.199	0.213	-0.014
police when transporting goods	(0.051)	(0.036)	(0.062)
Average percent of working capital financed	29.965	25.998	3.967
from formal sources (banks, on credit)	(2.905)	(1.981)	(3.516)
Average percent of working capital financed	2.955	2.180	0.774
from informal sources (family, moneylenders)	(1.176)	(0.733)	(1.386)
Regional indicators			
Nairobi	0.564	0.763	-0.199*
	(0.092)	(0.059)	(0.109)
Mombasa	0.409	0.221	0.187*
	(0.092)	(0.059)	(0.110)
Nakuru	0.015	0.007	0.008*
	(0.004)	(0.002)	(0.004)
Kisumu	0.012	0.008	0.004
	(0.004)	(0.002)	(0.004)

Table 4: Descriptive statistics disaggregated by gender of principal owner (continued)

	Firm has at least one female principal owner	Firm has no female principal owner	Difference (column 1 - column 2)
Firm and industry characteristics			
Natural log of number of years firm has been operating as of 2007	1.731 (0.156)	1.676 (0.121)	0.056 (0.198)
Natural log of value of machinery (machinery, vehicle equipment new and/or used)	5.891 (0.887)	7.065 (0.572)	-1.173 (1.056)
Natural log of value of property (land and buildings)	0.016 (0.006)	1.147 (0.398)	-1.131*** (0.398)
Natural log of total number of full-time employees	0.555 (0.095)	0.505 (0.070)	0.049 (0.118)
Natural log of total number of temporary employees	0.035 (0.008)	0.036 (0.006)	-0.001 (0.010)
Firm's industrial classification - manufacturing: food	0.004 (0.002)	0.018 (0.016)	-0.014 (0.016)
Firm's industrial classification - manufacturing: garment	0.105 (0.056)	0.055 (0.031)	0.051 (0.064)
Firm's industrial classification - manufacturing: other	0.071 (0.042)	0.311 (0.060)	-0.240*** (0.073)
Firm's industrial classification - retail	0.461 (0.091)	0.299 (0.060)	0.162 (0.109)
Firm's industrial classification - rest of the universe	0.359 (0.088)	0.318 (0.060)	0.042 (0.106)
Percent of firm owned by largest shareholders	95.990 (1.916)	95.888 (1.556)	0.103 (2.468)
Legal status of establishment: public	0.001 (0.001)	0.0002 (0.0002)	0.0004 (0.001)
Legal status of establishment: private	0.013 (0.003)	0.010 (0.002)	0.003 (0.004)
Legal status of establishment: sole proprietorship	0.910 (0.042)	0.896 (0.037)	0.015 (0.056)
Legal status of establishment: partnership	0.076 (0.042)	0.094 (0.037)	-0.018 (0.056)
Legal status of establishment: other	0.0001 (0.0001)	- -	0.0001 (0.0001)

Table 4: Descriptive statistics disaggregated by gender of principal owner (continued)

	Firm has at least one female principal owner	Firm has no female principal owner	Difference (column 1 - column 2)
Firm and industry characteristics			
Firm has 100 full-time paid employees or more	0.003	0.002	0.001
	(0.001)	(0.001)	(0.001)
Firm has 20-99 full-time paid employees	0.008	0.007	0.001
	(0.002)	(0.001)	(0.002)
Firm has 5-19 full-time paid employees	0.019	0.018	0.001
	(0.004)	(0.003)	(0.005)
Firm has fewer than 5 full-time paid employees	0.970	0.973	-0.003
	(0.006)	(0.004)	(0.007)
Firm has African-origin principal owner	0.962	0.993	-0.031
	(0.030)	(0.001)	(0.030)
Firm has Indian-origin principal owner	0.008	0.006	0.002
	(0.002)	(0.001)	(0.003)
Firm has Lebanese/Middle Eastern or other	0.002	0.003	-0.0004
Asian or European origin principal owner	(0.001)	(0.001)	(0.001)
Top manager's characteristics			
Years of managerial experience in this sector	7.617	8.016	-0.400
	(0.976)	(0.829)	(1.281)
Has MBA or PHD from Kenya or another country	0.006	0.003	0.003
	(0.002)	(0.001)	(0.002)

Notes: Weighted to national level with weights provided by the Enterprise Survey for Kenya. Table reports percentage values. Standard errors in parentheses. The notation *** is $p<0.01$, ** is $p<0.05$, * is $p<0.10$.

Table 5A: Marginal effects for technology ownership for all industries

	(1)	(2)	(3)	(4)
Obstacles related to				
regulations	0.187***	0.189***	0.374***	0.065***
	(0.034)	(0.030)	(0.065)	(0.041)
infrastructure	-0.050**	-0.052**	-0.059***	-0.020***
	(0.024)	(0.023)	(0.020)	(0.007)
security	0.003	-0.001	-0.010	-0.006
	(0.042)	(0.040)	(0.036)	(0.010)
workforce	0.054***	0.043***	0.037***	0.009
	(0.019)	(0.025)	(0.022)	(0.011)
corruption	-0.020	-0.011	0.017	-0.002
	(0.040)	(0.043)	(0.038)	(0.012)
finance	0.075***	0.073***	0.052***	0.009
	(0.018)	(0.022)	(0.023)	(0.005)
Establishment has one or more female		0.017*	0.818***	0.150***
principal owners		(0.007)	(0.055)	(0.169)
Female principal owner interactions with obstacles related to				
regulations			-0.344***	-0.041**
			(0.080)	(0.040)
infrastructure			0.075**	0.022***
			(0.044)	(0.009)
security			0.034*	0.004
			(0.018)	(0.006)
workforce			-0.012	-0.008
			(0.026)	(0.009)
corruption			-0.099***	-0.021
			(0.028)	(0.010)
finance			0.032	-0.001
			(0.017)	(0.006)
χ^2 *value of joint test of significance of female principal*			155.670	22.200
owner interaction terms			[0.000]	[0.000]
Includes regional indicators	NO	NO	NO	YES
Includes firm, industry, and top manager characteristics	NO	NO	NO	YES

Notes: Weighted to national level with weights provided by the Enterprise Survey for Kenya. Table reports marginal effects from probit regressions. Robust standard errors, clustered by region, in parentheses. *p*-values in square brackets. The notation *** is p<0.01, ** is p<0.05, * is p<0.10. Firm and industry characteristics include firm's age, indicators for large or medium firm, value of machinery and property, log of the number of permanent and temporary workers, whether any of the principal owners are of Indian origin, African origin, or Asian or European origin, indicators for three categories of manufacturing firms, retail firm, and "rest of the universe" firm, percentage of the firm held by the largest shareholders, and indicators for whether firm is public, private, sole proprietorship, partnership, or other. Top manager characteristics include whether she/he holds an MBA or Ph.D. and years of managerial experience working in this sector. Regressions have 778 firm level observations.

Table 5B: Marginal effects for technology ownership for industries where barriers to entry are relatively low for women-owned firms

	(1)	(2)	(3)	(4)
Obstacles related to				
regulations	0.200***	0.194***	0.229***	0.005***
	(0.070)	(0.072)	(0.115)	(0.002)
infrastructure	-0.0001	-0.001	-0.017***	-0.001***
	(0.012)	(0.012)	(0.010)	(0.0004)
security	0.017	0.015	0.008	0.001***
	(0.013)	(0.013)	(0.008)	(0.001)
workforce	0.021*	0.021*	0.021	-0.0001
	(0.021)	(0.021)	(0.024)	(0.0003)
corruption	-0.059***	-0.056**	-0.045**	-0.002**
	(0.026)	(0.025)	(0.022)	(0.001)
finance	0.072***	0.070***	0.072***	0.001
	(0.025)	(0.026)	(0.031)	(0.001)
Establishment has one or more female		0.003***	0.413**	-0.0004
principal owners		(0.001)	(0.460)	(0.001)
Female principal owner interactions with obstacles related to				
regulations			-0.096	-0.0001
			(0.112)	(0.001)
infrastructure			0.034**	0.001***
			(0.028)	(0.0003)
security			0.026	-0.0004
			(0.021)	(0.0005)
workforce			-0.003	-0.0003
			(0.017)	(0.001)
corruption			-0.022	0.0001
			(0.015)	(0.0004)
finance			-0.020	-0.0003
			(0.023)	(0.001)
χ^2 *value of joint test of significance of female principal*			8.020	0.650
owner interaction terms			[0.046]	[0.886]
Includes regional indicators	NO	NO	NO	YES
Includes firm, industry, and top manager characteristics	NO	NO	NO	YES

Notes: Weighted to national level with weights provided by the Enterprise Survey for Kenya. Table reports marginal effects from probit regressions. Robust standard errors, clustered by region, in parentheses. *p*-values in square brackets. The notation *** is p<0.01, ** is p<0.05, * is p<0.10. Firm and industry characteristics and top manager's characteristics are the same as those in Table 5A. Regressions have 502 firm level observations in industries that include garments, retail, food, textiles, non-metallic minerals, hotels & restaurants, construction & transport.

Table 5C: Marginal effects for technology ownership with objective measures of obstacles for all industries

Objective Measures of Obstacles	(1)	(2)
Establishment made protection payments (to organized crime to prevent violence)	-0.024	0.003
	(0.140)	(0.002)
Establishment paid for security (equipment, personnel, or security services)	-0.152**	-0.007***
	(0.066)	(0.0003)
Establishment made informal payments to the police when transporting goods	0.213**	
	(0.075)	
Average percent of working capital financed from formal sources (banks, on credit)	0.007*	0.0001*
	(0.004)	(0.00004)
Average percent of working capital financed from informal sources (family, moneylenders)	-0.008*	0.0002***
	(0.004)	(0.00005)
Establishment has one or more female principal owners	-0.019	0.005***
	(0.095)	(0.001)
Female principal owner interactions with:		
Establishment made protection payments (to organized crime to prevent violence)	0.050	0.003
	(0.132)	(0.001)
Establishment paid for security (equipment, personnel, or security services)	0.293	0.001
	(0.190)	(0.001)
Establishment made informal payments to the police when transporting goods	-0.135	
	(0.197)	
Average percent of working capital financed from formal sources (banks, on credit)	-0.007*	-0.0001***
	(0.003)	(0.00002)
Average percent of working capital financed from informal sources (family, moneylenders)	0.017**	-0.0003***
	(0.007)	(0.00005)
χ^2 *value of joint test of significance of female principal owner interaction terms*	11.66	39.29
	[0.009]	[0.000]
Includes regional indicators	YES	YES
Includes firm, industry, and top manager characteristics	YES	YES

Notes: Weighted to national level with weights provided by the Enterprise Survey for Kenya. Table reports marginal effects from probit regressions. Robust standard errors, clustered by region, in parentheses. *p*-values in square brackets. The notation *** is p<0.01, ** is p<0.05, * is p<0.10. Firm and industry characteristics include firm's age, indicators for large or medium firm, value of machinery and property, log of the number of permanent and temporary workers, whether any of the principal owners are of Indian origin, African origin, or Asian or European origin, indicators for three categories of manufacturing firms, retail firm, and "rest of the universe" firm, percentage of the firm held by the largest shareholders, and indicators for whether firm is public, private, sole proprietorship, partnership, or other. Top manager characteristics include whether she/he holds an MBA or Ph.D. from Kenya or abroad and years of managerial experience working in this sector. Column (1) had 503 firm level observations and column (2) has 776 firm level observations.

Table 5D: Marginal effects for technology ownership with objective measures of obstacles for industries where barriers to entry are relatively low for women-owned firms

Objective Measures of Obstacles	(1)	(2)
Establishment made protection payments (to organized crime to prevent violence)	-0.607***	-0.0003
	(0.096)	(0.0004)
Establishment paid for security (equipment, personnel, or security services)	-0.342	-0.0001***
	(0.220)	(0.0001)
Establishment made informal payments to the police when transporting goods	0.124**	
	(0.054)	
Average percent of working capital financed from formal sources (banks, on credit)	0.001	-0.000001
	(0.005)	(0.000001)
Average percent of working capital financed from informal sources (family, moneylenders)	-0.022***	-0.000001
	(0.006)	(0.000001)
Establishment has one or more female principal owners	-0.184	0.000001
	(0.148)	(0.00002)
Female principal owner interactions with:		
Establishment made protection payments (to organized crime to prevent violence)	-0.185	0.00002***
	(0.140)	(0.00003)
Establishment paid for security (equipment, personnel, or security services)	0.308	0.00002*
	(0.385)	(0.00003)
Establishment made informal payments to the police when transporting goods	0.470***	
	(0.085)	
Average percent of working capital financed from formal sources (banks, on credit)	-0.008	-0.00000002
	(0.005)	(0.000001)
Average percent of working capital financed from informal sources (family, moneylenders)	0.0002	0.000001
	(0.005)	(0.000001)
χ^2 *value of joint test of significance of female principal owner interaction terms*	379.470	10.360
	[0.000]	[0.016]
Includes regional indicators	YES	YES
Includes firm, industry, and top manager characteristics	YES	YES

Notes: Weighted to national level with weights provided by the Enterprise Survey for Kenya. Table reports marginal effects from probit regressions. Robust standard errors, clustered by region, in parentheses. *p*-values in square brackets. The notation *** is p<0.01, ** is p<0.05, * is p<0.10. Firm and industry characteristics and top manager's characteristics are the same as those in Table 5C. Regressions have 502 firm level observations in industries that include garments, retail, food, textiles, non-metallic minerals, hotels & restaurants, construction & transport.

Table 6A: Average predicted probabilities using female firm and male firm sample data and female firm and male firm coefficients

	All Industries				**Industries with Low Barriers to Entry for Women**			
	Firms with female owners		*Firms without female owners*		*Firms with female owners*		*Firms without female owners*	
	β_f	β_m	β_f	β_m	β_f	β_m	β_f	β_m
Technology	0.985	0.967	0.986	0.970	0.983	0.982	0.976	0.973

Notes: Industries with low barriers to entry include garment, retail, food, textiles, non-metallic minerals, hotels & restaurants, and construction and transport. All industries includes a sample size of 778 firms of which 286 have female principal owners and 492 have only male principal owners. Industries with low barriers to entry includes a sample size of 502 firms of which 215 have female principal owners and 287 have only male principal owners.

Table 6B: Decomposition of average predicted probabilities using an Oaxaca-Blinder type method

	All Industries				**Industries with Low Barriers to Entry for Women**			
	Total observed Gap	*Explained Gap*	*Residual Gap*	*(Residual gap/ Total observed gap)*	*Total observed Gap*	*Explained Gap*	*Residual Gap*	*(Residual gap/ Total observed gap)*
Technology	-0.015	0.004	-0.018	1.243	-0.010	-0.008	-0.002	0.176

Notes: Reports results of the decomposition when male firm coefficients are used as weights. Results with female firm coefficients are comparable. Industries with low barriers to entry include garment, retail, food, textiles, non-metallic minerals, hotels & restaurants, and construction and transport. All industries includes a sample size of 778 firms of which 286 have female principal owners and 492 have only male principal owners. Industries with low barriers to entry includes a sample size of 502 firms of which 215 have female principal owners and 287 have only male principal owners.

[1] A pair-wise weighted correlation matrix of the 6 obstacles studied here (regulations, infrastructure, security, workforce, corruption, finance) indicates that the majority are significantly correlated - even things as distinct as infrastructure and workforce, and infrastructure and finance.

[2] Note that these data cannot address entry into entrepreneurship as it includes a random sample of firms that are already in existence.

[3] The majority of businesses in Kenya are Small and medium enterprises (SMEs). These are often rural-based and owner-owned and managed, flexible, with low labor costs and low costs of raw materials. In recent times, technology intensive SMEs have arisen, particularly in the technology intensive industries. Given their specific nature, SMEs in Kenya have noted advantages including the ability to generate employment, high level of productivity, and the means to rapidly absorb new technical innovations (Atieno, 2009).

[4] This is similar to the methodology in Amin (2009).

[5] For purposes of this study, we consider the ownership of computers, generators, and cell-phones combined. We can study effects separately for computers alone, but there is relatively little variation in generator and cell-phone ownership for us to examine separate effects for these two technologies, and whether the effects diverge by gender of the firm's owner.

[6] Results using female coefficients as weights are comparable. Furthermore, the decomposition was performed with and without the constant term. Results with and without the constant term were close to the sixth decimal place, mainly because we condition on a large set of regional, firm, industry, and top manager characteristics. Given the appreciable lack of difference in estimates, we report results for the models that include the constant term.