# Success in Entrepreneurship: Doing the Math

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This paper examines the association between entrepreneurial success and firm and owner characteristics, in the context of the small retail sector in Western Kenya. Earlier work finds very high rates of return to inventories. Inventories are positively associated with math skills. Since inventories and profits are positively correlated, math skills predict profits as well. Math skills are also robustly correlated with profits conditional on inventories.

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## 1. Introduction

Outside of agriculture, the family owned business is the most common form of enterprise in low-income countries. These types of businesses employ hundreds of millions of people (i.e., Banerjee and Duflo, 2007; World Bank, 2004), yet there is tremendous heterogeneity in how such firms perform. For instance, in the retail sector, some firms hold large inventories and earn significant profits, while others hold minimal stocks and provide little more than subsistence income for their owners. However, it is an open question why there is such heterogeneity in the success of small firms. This paper examines these issues in the context of one specific industry, retail, in a region of Western Kenya.

A companion paper (Kremer et al., 2013a) calculates bounds on the marginal returns to inventories for a sample of retail firms in Western Kenya. The results suggest some firms have high returns to inventories, but that returns vary greatly across firms. The study leverages administrative data from a wholesaler on whether firms purchased enough to take advantage of quantity discounts. While many orders just qualify for a discount, many others are just below the quantity threshold. In our sample, the median shop misses at least some opportunities to earn rates of return in excess of 100% (by increasing one purchase slightly to meet the bulk discount threshold and correspondingly reducing the next purchase).[1]

These results are consistent with a series of papers suggesting that many small firms in developing countries face high returns to capital (i.e., de Mel et al. 2008; Duflo, Kremer and Robinson 2011; McKenzie and Woodruff 2008; Fafchamps et al. 2011; Udry and Anagol 2006; and Banerjee and Duflo 2012).

[1] We also measure the return to increased investment by surveying shops on a regular basis about "stockouts": lost sales due to insufficient inventory. The average bounds on returns are more modest with this approach - the average shop in our sample would achieve a real rate of return of 33 percent to a marginal increase in inventory per year, and 17.6 percent of shops have returns greater than 50%. However, if lost customer goodwill or other sales of complementary goods are significant, this will be a very loose lower bound on the rate of return. We were also able to reject the hypothesis that the marginal rates of return are equal across shops.

This study focuses not on the marginal return to inventory but on the correlates of overall inventory and profit levels. Background data was collected on a large sample of retail shops using detailed surveys on a host of firm and owner characteristics. The survey included vocabulary and reading tests in English and Swahili, a math problem solving test, a digit recall memory test, Raven progressive matrices, and a maze completion speed test. The survey included modules on demographics; access to savings and credit; ownership of land, durable goods, and other assets; transfers given and received; income; and financial recordkeeping and other business practices. Incentivized modules to measure time preferences and small-stakes risk aversion were also administered. To measure time preferences, respondents were asked to choose between several schedules of time-dated cash payouts. To measure small-stakes risk aversion, subjects were asked to divide a portfolio of 100 Ksh (approximately $1.33) between a safe asset and a risky asset that paid zero with 50% probability and 2.5 times the amount invested with 50% probability.

This paper examines two main business outcomes: inventory size, and profits. For inventories, several correlates are identified. Firm owners with higher math scores, younger firm owners, and firm owners who are less risk averse over small stakes have larger inventories. Shop keepers with bank accounts also tend to have somewhat larger inventories.

Consistent with our findings that firms with larger inventories have higher profits, these differences translate into profits as well. Firm owners with higher math scores earn higher profits, even conditional on inventories.

The rest of this paper is organized as follows. Section 2 reviews the related literature, Section 3 describes the data, Section 4 discusses the results, and Section 5 concludes.

## 2. Literature Review

### 2.1 Personality Characteristics and Entrepreneurship

This work fits into a broad multi-disciplinary literature that aims to identify factors correlated with entrepreneurship entry and success.

Most studies in this field have examined the link between various personality characteristics and the decision to enter entrepreneurship. A number of papers argue that characteristics such as risk and autonomy preferences, innovative orientation, and locus of control predict entrepreneurship.[2]

Hartog et al. (2010) use the U.S. National Longitudinal Study of Youth to examine the effects of various personal characteristics among entrepreneurs and employees. They find that verbal abilities appear to be more important for employees, while mathematical, technical and social abilities are more important for entrepreneurs. They also argue that general ability and balance across the various kinds of ability generate higher incomes for entrepreneurs.

Caliendo et al. (2010) find that entrepreneurs with intermediate levels of risk tolerance survive longer than entrepreneurs with very high or very low levels of tolerance for risk. Fairlie and Holleran (2011) find that more risk tolerant individuals and those with a preference for autonomy benefit more from business training.

A smaller literature has focused on entrepreneurs in developing countries. De Mel, McKenzie and Woodruff (2008, 2009, 2010) present a large amount of evidence from a sample of small firms in Sri Lanka. In de Mel et al. (2010), the authors find evidence that micro-entrepreneurs in Sri Lanka bear more similarities to wage workers in developed

[2] For example, see Zhao and Seibert (2006), Blanchflower and Oswald (1998), Rauch and Frese (2007), Caliendo et al. (2010), Evans and Leighton (1989), Puri and Robinson (2009). See Rauch and Frese (2007) for a meta-analysis of this literature.

countries than to owners of large firms.[3] de Mel et al. (2008) find that capital injections are most beneficial to those that score highest on a digits forward memory test and de Mel et al. (2009) find that several owner characteristics predict innovation (defined as new or significantly improved product, process, marketing or organization changes). Predictive characteristics include Raven's test scores, optimism measures, previous experience, and time preferences.

### 2.2. Returns to Capital, Credit, Business Training, and Microcredit

This paper is related to several strands of literature within development. First, a host of recent studies have found extremely high marginal rates of return to capital in developing countries (see, for example, de Mel et al. 2008; McKenzie and Woodruff 2008; Banerjee and Duflo 2012; Udry and Anagol 2007; and Fafchamps et al. 2011). Such high returns are puzzling, however: it is unclear why firms cannot realize these returns and why owners of small firms do not accumulate more capital until rates of return fall to a more conventional level, as would be suggested by a standard Euler equation. While a possible explanation would be that credit constraints are binding, this seems unlikely to be the whole story since the Euler equation would hold even under credit constraints. Relatedly, a number of recent randomized experiments on microfinance have found limited take-up for microcredit loans, at least as currently offered by microfinance providers. This is true in India (Banerjee et al. 2010), the Philippines (Karlan and Zinman, 2010), and Morocco (Crépon et al. 2011). Attanasio et al. (2011) find somewhat higher take-up in in Mongolia, yet even there about half of the loans were used for household, rather than business, expenses.

[3] A meta-review of empirical work in developing countries (Van der Sluis, 2005) finds that more educated workers are more likely to be in wage employment than in nonfarm entrepreneurship, and find that the effect is stronger for women, and in least developed countries.

Another explanation for high unrealized returns is that human capital constraints are binding. Most studies of providing standard business training to entrepreneurs find limited effects (see Karlan and Valdivia 2010 in Peru; Giné and Mansuri 2011 in Pakistan; Bruhn and Zia 2011 in Bosnia and Herzegovina, and the standard business training provided in Drexler et al. 2010 in the Dominican Republic). Fairlie et al. (2012) find similarly small effects of business training among potential entrepreneurs in the US. By contrast, Drexler et al. (2011) find larger effects from "rule of thumb" training in the Dominican Republic, which emphasized basic cash management strategies (such as keeping separate accounts for the business and for personal consumption). Working with much larger firms, Bloom et al. (2013) find that providing basic management consulting to Indian textile firms increases total factor productivity by 18%, even though many of the changes implemented were already available to firms. Bruhn, Karlan, and Schoar (2012) also find large effects of management consulting among Mexican firms.

## 3. Data

### 3.1. The Small Scale Retail Sector in Kenya

The small-scale retail sector comprises a significant share of economic activity in Kenya, particularly in rural areas. For example, Daniels and Mead (1998) estimate that small and medium enterprises with ten or fewer employees (not including agriculture and mineral extraction industries) comprise 12-14% of total Kenyan GDP, and that a quarter of this contribution comes from the retail trade.

This study focuses on a category of retail shops in Western Kenya called *dukas* in Kiswahili. These shops are typically owner-operated and are ubiquitous in market centers and small towns in the region. They are often located in clusters, adjacent or in close proximity to

several competing shops and retail fast moving consumer goods (FMCG), or consumer packaged goods (CPG). The FMCG manufacturing industry is highly concentrated. Manufacturers set retail prices, and a single supplier has a very high market share.

Western Kenya is relatively poor, and people tend to buy a fairly small set of goods. Consequently, shops typically sell a relatively homogeneous set of goods, which include basic household products such as perishable and non-perishable foodstuffs, soaps, detergents, cooking fat, sodas, phone cards, and other household items. The more successful shops tend to stock a wider variety of goods, rarely stock out of items, and purchase sufficiently large quantities to qualify for bulk discounts.

Several features of the industry may make it possible for less productive firms to survive, rather than be driven out by more efficient competitors. First, efficient shopkeepers are typically not able to manage multiple shops in different locations. Whether this is due to labor market frictions, moral hazard with employees, or other factors, such constraints set a limit on the scope of firm operations. Second, since many customers tend to travel a short distance to purchase items, shops face only limited competition. Finally, manufacturers preclude price competition by fixing retail prices.

### 3.2. Sampling

Some of the data used in this analysis was collected for a companion paper (Kremer et al., 2013a). Firms were sampled from the administrative records of a large distributor of household goods. From the universe of shops in this database, a sample of 854 shops was identified for surveying, spanning a relatively wide geographical area in Western Kenya.[4]

[4] The inclusion criterion was that the shops were close enough for enumerators to be able to travel to the shop to conduct surveys.

Background surveys were successfully completed with 731 of these shops (85.6%) in 2009-2010. The remaining shops were untraceable, mostly because they had closed.

This paper focuses on the dependent variables of inventory size, and profits. The first two measures were collected as part of an endline survey in our companion paper. Of the 731 firms with baseline data, 486 were sampled for an endline survey that includes the inventory measures used in this paper, and which was administered approximately 1.5-2 years after the baseline surveys (between February and May 2011). Enumerators successfully completed surveys with 380 of these shops (78.1%). Approximately halfway through the administration of these surveys, the profit module was added to the questionnaire. Therefore, there is a smaller number of observations for that variable (188).

Lastly, survival information on shops was collected when enumerators visited market centers on endline survey. The dataset contains useable information on 700 of the 731 shops (95.8%). Information on the remaining shops unfortunately could not be obtained.

### 3.3. Survey Data

#### *3.3.1. Background Surveys*

The background survey gathered information on a number of standard demographic measures such as the owner's age, sex, ethnicity, educational attainment, literacy, the size of the owner's family, and how long the shop had been open. The survey also included questions on the shop owner’s access to and use of savings and credit; self-reported credit constraints; land, durable goods and other asset holdings; and other sources of income.

In addition, survey instruments included tests of cognitive ability and various psychological measures, including time and risk preferences, as well as attitudes towards entrepreneurship. Established cognitive tests were adapted to the local context to measure

language and math ability, memory, and general reasoning ability. Specifically, the survey included vocabulary and reading tests in English and Swahili, a math problem solving test, a digit recall memory test, Raven progressive matrices and a maze completion speed test. For the analysis, the results of several of these variables were aggregated for the cases where there was substantial correlation (for example, measures of vocabulary and language, as well as competency in English and in Swahili).

This paper focuses specifically on the math test results. This test was adapted from standard psychometric and personnel IQ tests, including the Wonderlic Test and Cognitive Reflection Test and included eleven questions that ranged from simple math calculations (e.g., "A notebook costs 21 Ksh for each one. What will four notebooks cost?"), to more challenging analytical reasoning questions (e.g., "In a lake, there is a patch of water hyacinths. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake?"). The questions used in this analysis are included in the Appendix.

Time and risk preferences were assessed by asking respondents to make choices over a variety of incentive-compatible choice sets. To incentivize truth-telling, one question was randomly chosen at the end of the interview and the corresponding amount was paid to the respondent. To measure small stakes risk aversion, respondents were asked how much of a given amount of money they would like to put into a risky asset. The money invested in the risky asset was multiplied by 2.5 with 50% probability and was completely lost the other half of the time. The remainder of the money was kept with certainty.

To estimate time preferences, respondents were asked to choose between a given amount of money (40 Kenyan shillings, or about $0.50) at a particular date and a larger amount one month later. To estimate time consistency, these questions were asked over two time frames: (1) immediately vs. one month in the future, and (2) one month in the future vs.

two months in the future. In the analysis, respondents were coded as being "patient" if they preferred to wait one month for 55 Ksh to taking 40 Ksh now. In addition, several measures of time-consistency were constructed: (1) "time-consistent" individuals who exhibit the same discount rate in the present as in the future, (2) "present-biased" individuals who are more patient in the future than in the present, (3) "patient now but impatient later" individuals who are more patient in the present than in the future, and (4) people who exhibit the maximal discount rate in both the present and the future (these people prefer 40 Ksh earlier to 500 Ksh a month later, no matter what the time period is).

Finally, respondents were asked questions related to their entrepreneurial disposition and other attitudinal characteristics. Questions developed by the World Values Survey were used to the extent possible, and questions were adapted to the local context.

### *3.3.2. Inventory and Profit Surveys*

Self-reported profits and inventory were collected between February and May 2011, approximately 1.5-2 years after the background surveys. As shops stock a large number of products, it was too burdensome for the respondents to measure inventories product by product. Respondents were therefore asked to estimate the total value of their inventory (at both wholesale and retail prices) with the enumerator's assistance. In addition, the respondent, together with the enumerator, calculated the value of the thirteen most common items stocked by shops. The methodology to measure profits follows de Mel, McKenzie, and Woodruff (2008).[5] Respondents were asked to report their income, less expenses and other employee wages, over the previous 30 days. Unfortunately, these questions were included for only a subset of the shops that were surveyed (since this set of questions was not included in

[5] See de Mel et al. (2009b) for a discussion of the difficulty in measuring profits, and a justification for using this method.

the first rounds of the survey due to its substantial length). Therefore, there are only 188 shops with profit data.

The mean value of total inventory was 265,200 Ksh (approximately $3,500), more than double of Kenyan per capita GDP, and representing twice the mean value of the durable goods and animals owned by the shop keepers in our sample. Mean reported monthly profits were 23,900 Ksh (~$320). Both the inventory and profit distributions were quite skewed: the median total inventory and median monthly profits were almost half of the means, valued at $2,000 and $160 respectively. The 75$^{th}$ percentile was at $4,000 and the 90$^{th}$ at $9,300. On the other hand, the 25$^{th}$ percentile was at $1,100. Similar distributions were observed for the inventory calculated using the top thirteen items, as well as for profits.

### *3.3.3. Firm Survival*

The final outcome measure comes from a census conducted in May 2011 (at the conclusion of the endline surveys). At that time, enumerators visited every shop from the baseline sample to collect data on whether the firm was still in business at that time. Since collecting this information did not require a survey, it could be obtained for a much larger sample of shops (700). While the enumerators attempted to collect data on the reasons for exits, they were unable to obtain good tracking information for most of the shops that had closed and thus there is no reliable information on what jobs the shop owners took after exiting.

Note that it is difficult to say whether survival of a retail shop is a positive or negative outcome in this setting: it may well be that other, more formal jobs are preferred to small retail employment.

### *3.3.4. Summary Statistics*

Summary statistics for the 380 shops in the inventory analysis are presented in Table 1.[6] The average shopkeeper has 10.8 years of education, substantially more than the typical rural resident in the area, and 97% can read and write in Kiswahili. The mean shop has been aroung for almost 7.5 years, and the average shopkeeper is about 33 years old. Fifty-six percent of shopkeepers are male.

Shopkeepers are substantially wealthier than the average rural resident. About 13% of owners or their spouses have formal sector jobs, a figure which is much higher than for the typical rural residents. In addition, 83% of shopkeepers in our sample have bank accounts, 42% participate in a merry-go-round cooperative (ROSCA), and the average shopkeeper owns 1.95 acres of land. Inventory value and income distributions among shopkeepers are skewed, but even at the 25th percentile shopkeepers have relatively high incomes and wealth in an area where typical agricultural wages are approximately one dollar a day.

Thirty-seven percent of shops report that they would like to borrow money but are unable to do so, while 31% keep financial records.

The table also reports information on small-stakes risk aversion. The average shopkeeper invested a bit more than 50% into the risky asset. Interestingly, about one third of the shopkeepers divided money exactly equally between the risky and safe assets, a result which is consistent with workers in the US who follow the "1/n" heuristic of investing in retirement assets (i.e., Benartzi and Thaler 2001, 2007). Since individuals should be close to risk neutral over such small stakes (i.e., Rabin 2001), the lumping at an equal division of assets suggests that investment behavior is not consistent with expected utility maximization.

[6] Summary statistics for the larger sample of shops with survival data are presented in Table A1.

In terms of time preferences in laboratory games, respondents appear very impatient on average. Only 8% of people are willing to wait a month for 55 Ksh instead of receiving 40 Ksh immediately. While this may suggest high discount rates, this measure may be confounded by trust concerns as well. Only 20% of people are time-consistent, whereas 52% are present-biased.

Of the attitudinal variables, a "Work Importance" index was constructed by averaging responses to the following four questions: (1) A binary variable equal to 1 if the respondent answers "all the time" to the question "How often do you think about your business?"; (2) A binary variable taking value 1 if the shopkeeper reports that she tends to choose work over family; (3) A binary variable taking value 1 for shop keepers who say that work is "very important"; and (4) A binary variable taking value 1 for those who say their goal in the business is to "make a lot of money." The average of this index is 0.36 in the sample. Finally, the last row of the table shows that only 31% of shops always keep financial records.

### *3.3.5. Mathematical Ability*

Figure 1 shows the distribution of scores on the eleven-question mathematical test.[7] As can be seen, there is quite a bit of variation in scores. The interquartile range is 0.36-0.6, while the mean and median are 0.49 and 0.45, respectively. To examine how scores on the math test are correlated with other measures, Table 2 examines the relationship between mathematical ability, education, and other cognitive measures (note that this table includes data from all shopkeepers who completed the math test in the baseline sample, whether or not they were in the endline). In Column 1, the standardized math score is regressed on years of education. The correlation is positive, large and highly significant: an additional year of

[7] Note that some subjects did not answer all questions, some questions were filled in incorrectly or were subject to data entry errors. Therefore, data is not available for answers to all questions for all respondents.

education is associated with an additional 0.13 standard deviation score on the Math test. Column 2 includes other controls, including standardized measures of digit recall, maze completion times, Raven's matrix score, and a combined English/Kiswahili language score. These covariates somewhat attenuate the effect of education (from 0.13 to 0.07 standard deviations per year of education), but the coefficient is still highly significant. The results do not suggest statistically significant correlations between the math score and either the Raven's score or the language score.

As will be discussed in greater detail in the following sections, these correlations are important for two reasons. First, they provide some reassurance that these measures contain some signal. Second, the correlation with education at least suggests that mathematical ability is not an innate individual characteristic but is something that could potentially be improved with training.

## 4. Results

### 4.1. Inventory Size

First, the multivariate correlates of inventory size are considered, using the two measures of (log) inventories, both in Kenyan shillings. In Columns 1-3, the dependent variable is log total inventory on all items; in Columns 4-6, it is log inventory on the top thirteen items. In the first specification (Columns 1 and 4), only those variables that are most plausibly exogenous are included. In addition to demographic characteristics, these include measures of cognitive ability, small-stakes risk aversion, asset ownership and income from formal sector jobs. In the second specification (Columns 2 and 5), measures of financial access are added. In the final specification (Columns 3 and 6), time preferences, attitudinal measures and financial recordkeeping are also included.

The most compelling associations emerge with respect to the cognitive measures. There is strong evidence that shopkeepers' performance on the math test predicts inventory size. As with small-stakes risk aversion, this association is robust to controlling for measures of credit constraints and other variables. A one standard deviation increase in the math score is robustly associated with 16-18% higher inventories. Raven's matrix scores are also significant in predicting the inventory of the top 13 products (Columns 4-6), but are not significant with regards to total inventory.

The only demographic variable correlated with inventories is the shopkeeper's age: firms with younger owners tend to have larger inventories. There is some evidence that some measures of credit constrains may be important, though the overall pattern of results does not provide definitive evidence one way or the other. Higher levels of other assets are weakly correlated larger inventories. However, there is no significant correlation between inventories and self-reported credit constraints, land ownership, or formal sector employment. There is some evidence that those with bank accounts have larger inventories, while members of savings circles called ROSCAs (Rotating Savings and Credit Associations) have smaller inventories (Kremer et al., 2013b). While it is difficult to interpret this causally, one possible explanation is that most shopkeepers have bank accounts (as can be seen from Table 1, 82% have bank accounts) and thus shopkeepers who save in ROSCAs may be worse off than the average shopkeeper.

There is strong evidence that small stakes loss aversion is significantly correlated with lower inventories. This correlation is robust to controlling for measures of credit constraints, as well as for other variables. Shopkeepers who invested 10% less of the 100 Ksh portfolio (i.e., 10 Ksh) in the risky asset had approximately 6.6-8.1% higher inventories. While it is possible that the decision of how much to allocate to a risky portfolio is endogenous to business performance such that less successful shopkeepers invest less in the asset, this seems

unlikely given the small stakes: 10 Ksh represents only around 1/700$^{th}$ of the value of the median shopkeeper's durable goods and animal assets, and only around 1/1400$^{th}$ of the value of the median respondent's inventory.

There is also evidence that some measures of time preferences are associated with inventories. Though these are less clearly exogenous to inventory size, the patterns are intuitive - present-biased owners hold smaller inventories. However, the measure of "patience" in the present is not correlated with inventories.

The work importance index and financial record-keeping are correlated with inventories in ways that seem sensible. Owners who place more importance on work at the expense of other activities hold bigger inventories, as do owners who always keep financial records.

### 4.2. Profits

Next, the correlates of shops' reported profits over the last 30 days of operation are examined (Table 4). The first three specifications in this table are identical to those in Table 3. Since inventories and profits are positively correlated, two more specifications are added. Column 4 includes a control for log total inventory size while Column 5 includes log inventory of top 13 items. This was done to examine whether the relationships between profits and owner and shop characteristics work entirely through inventories (such that certain types of shop keepers run larger shops), or whether certain types of people are better able to manage a given amount of inventory.

The only covariate which is robustly significant both with and without an inventory control is the math score. Unconditional on inventories, a one standard deviation increase in the math score is associated with 31-32% higher profits; conditional on inventories, the figure falls by about half, suggesting that that one of the main channels through which quantitative

ability factors into profits is inventory management (Columns 4-5, Table 5). However, even conditional on inventories, quantitative ability appears to be an important predictor of profits.

Though there are fewer other correlates that are statistically significant, the pattern is roughly similar. There are several correlates which are statistically significant when inventories are not included as a control: younger shop owners, shop owners who keep financial records, and shop owners who place higher importance on work all tend to earn higher profits. One somewhat surprising result is that shop owners who are rated as "patient" earn less (i.e., those that prefer 55 Ksh or less in 1 month to 40 Ksh now). In any case, none of these covariates remain significant when inventories are included (Column 4-5), suggesting that they work principally through an inventory channel.

Again, small-stakes risk aversion is positively correlated with profits. The data suggests that this association works mostly through the inventory channel (see Columns 4-5): the coefficient is attenuated to about one quarter of its size, and is no longer significant, when inventories are included as a control.

### 4.3. Firm Survival

Table 5 examines multivariate regressions correlates of firm survival. Overall, 91% of businesses were still open in May 2011, implying an annual exit rate of approximately 4-6%. Few background characteristics predict survival. Unsurprisingly, the longer a shop has been open the more likely it is to survive. The Raven's matrix cognitive measure positively correlates with survival while the math score is not predictive at all. None of the proxies for credit constraints are correlated with survival.

The only strongly predictive characteristic is small stakes risk aversion, suggesting that shop owners who are less risk averse over small stakes are actually *less* likely to remain

in business. This last result suggests that survival may not be a positive outcome for shopkeepers (unfortunately, data on reasons for exit could not be obtained). In particular, exiting small retail into salaried work would typically make people better off. That there are not many robust predictors of survival would be consistent with this view, as would the correlation between scores on Raven's matrix pattern recognition task and likelihood of survival. Potentially, this suggests that successful retail shops exit into other, more profitable businesses.

## 5. Conclusion

This paper examines correlates of various measures of entrepreneurial success with shop and owner characteristics among small retailers in Western Kenya. The finding that stands out most strongly is a very high correlation of math scores with our measures of success. Math scores seem to be a robust predictor of inventories. They also strongly predict profits, and while one channel seems to be inventories math scores appear to important beyond this: the regression of profits on math scores controlling for inventories still shows a significant positive coefficient. Unsurprisingly, math scores are highly correlated with education. One hypothesis worth examining is that programs to improve math skills may be able increase the success of entrepreneurs.

Interestingly, other cognitive measures, such as language scores, Raven matrix tests, digit recall and time to complete mazes are not as robustly correlated with entrepreneurial success. There is some evidence that there is a relationship between inventory size and some measures of credit constraints. Other factors seem to be somewhat important as well. Present-biased shopkeepers have smaller shops. Shopkeepers who regularly keep financial records and shopkeepers who report placing a higher value on work over other aspects of their lives

have larger shops. However, our analysis does not find correlations of inventories or profits with most shop-owner characteristics (i.e., years of education, formal sector income, land ownership, and self-reported credit constraints).

A very strong relationship between inventories and small-stakes risk aversion was also observed. As risk aversion over such small stakes is implausible for expected utility maximizers (i.e., Rabin 2000), our companion paper (Kremer et al. 2013b) postulates that the correlation between small-stakes risk aversion and inventory size is due to loss aversion. As discussed in that paper, loss aversion may be an explanation for why millions of firms are unable to exploit potential profit opportunities.

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**Figure 1. Distribution of Scores on Math Test**

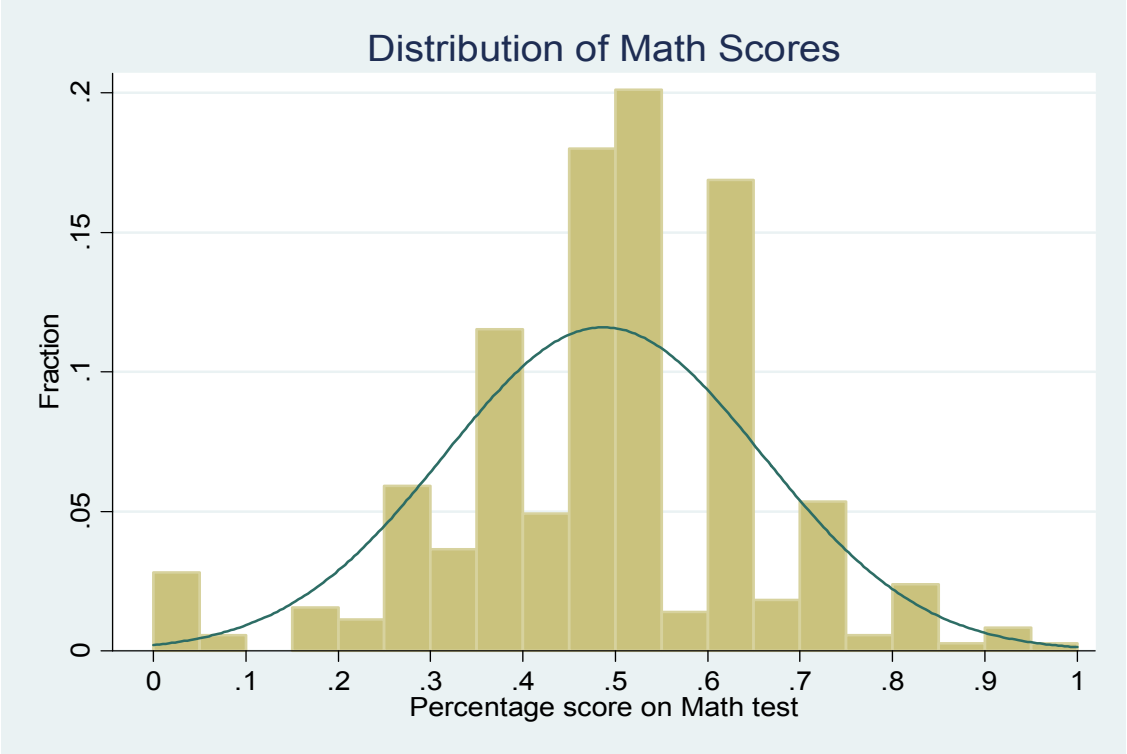

**Table 1. Summary Statistics for Sample of Shops with Inventory Data**

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | | | Quantiles | | | |
| | Mean | Std. Dev. | 25th | 50th | 75th | 90th |
| ***Inventories, Profits, and Credit to Customers*** | | | | | | |
| Total Inventory | 26.52 | 29.67 | 8.00 | 15.00 | 30.00 | 70.00 |
| Inventory in Top 13 Items | 9.42 | 11.34 | 2.80 | 5.16 | 10.81 | 24.93 |
| Profits in past month | 2.39 | 2.70 | 0.80 | 1.20 | 3.00 | 5.60 |
| Gives out credit to customers | 0.92 | - | - | - | - | - |
| Amount given out in credit in past month | 1.12 | 5.75 | 0.10 | 0.20 | 0.50 | 1.50 |
| ***Background Characteristics*** | | | | | | |
| Years of Education | 10.80 | 3.33 | 8.00 | 11.50 | 12.00 | 16.00 |
| Years Shop Open | 7.47 | 5.60 | 3.16 | 6.41 | 9.90 | 14.56 |
| Male | 0.56 | - | - | - | - | - |
| Married | 0.79 | - | - | - | - | - |
| Age | 33.36 | 9.48 | 27.00 | 32.00 | 38.00 | 46.00 |
| Can Read and Write (Swahili) | 0.97 | | | | | |
| ***Asset Ownership and Formal Sector Income*** | | | | | | |
| Owner or spouse has a formal sector job | 0.13 | - | - | - | - | - |
| Acres land owned | 1.95 | 2.64 | 0.00 | 1.00 | 2.50 | 4.50 |
| Value of durable goods and animals owned | 11.70 | 15.32 | 4.20 | 7.00 | 11.91 | 25.50 |
| ***Financial Access*** | | | | | | |
| Has bank account | 0.83 | - | - | - | - | - |
| Participates in ROSCA | 0.42 | - | - | - | - | - |
| Would you like to borrow more money but are unable to get it (percentage "yes") | 0.37 | - | - | - | - | - |
| ***Small Stakes Risk Aversion*** | | | | | | |
| Percentage Invested in Risky Asset | 0.56 | 0.20 | 0.50 | 0.50 | 0.70 | 0.80 |
| ***Time Preferences*** | | | | | | |
| "Patient:" Prefers 55 Ksh or less in 1 month to 40 Ksh today | 0.08 | - | - | - | - | - |
| Time Consistent | 0.20 | - | - | - | - | - |
| Present biased | 0.52 | - | - | - | - | - |
| Patient now but impatient later | 0.06 | - | - | - | - | - |
| Maximally impatient in present and future | 0.22 | - | - | - | - | - |
| ***Attitudinal Measures*** | | | | | | |
| Work Importance Index | 0.36 | 0.19 | 0.25 | 0.25 | 0.50 | 0.50 |
| ***Financial Recordkeeping*** | | | | | | |
| Always keeps financial records | 0.31 | - | - | - | - | - |

Notes: There are 380 shops in the sample. Sample size differs for some variables. All monetary values in 10,000 Kenyan shillings. Exchange rate was roughly 75 Ksh to $1.

**Table 2. Correlates of Standardized Math Score**

| | (1) | (2) |
|---|---|---|
| Years of Education (in tens of years) | 0.13 | 0.07 |
| | (0.01)*** | (0.01)*** |
| Digit recall (standardized) | | 0.03 |
| | | (0.04) |
| Seconds to finish mazes (standardized) | | -0.02 |
| | | (0.04) |
| Raven's matrix (standardized) | | 0.26 |
| | | (0.04)*** |
| Combined language score (standardized) | | 0.09 |
| | | (0.04)** |
| Observations | 670 | 620 |
| R-squared | 0.19 | 0.22 |

Notes: The dependent variable is the score on the math exam. Regressions include all firms with either inventory/profit data, or survival data. To avoid dropping observations, we create dummy variables for having missing information for a given variable and code the underlying variable as a 0 when it is missing. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

**Table 3. Correlates of Inventories**

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Log Total Inventory | | | Log Inventory on Top 13 Products | | |
| ***Background Characteristics*** | | | | | | |
| Years of Education (tens of years) | -0.06 | -0.09 | -0.14 | 0.04 | -0.01 | -0.06 |
| | (0.20) | (0.20) | (0.20) | (0.21) | (0.21) | (0.21) |
| Years Shop Open (tens of years) | 0.16 | 0.12 | 0.16 | 0.20 | 0.17 | 0.20 |
| | (0.10) | (0.10) | (0.10) | (0.11)* | (0.11) | (0.11)* |
| Age | -0.01 | -0.02 | -0.01 | -0.02 | -0.02 | -0.02 |
| | (0.01)** | (0.01)*** | (0.01)** | (0.01)*** | (0.01)*** | (0.01)*** |
| ***Cognitive Measures*** | | | | | | |
| Math score (standardized) | 0.18 | 0.18 | 0.16 | 0.14 | 0.14 | 0.12 |
| | (0.06)*** | (0.06)*** | (0.06)*** | (0.06)** | (0.06)** | (0.06)* |
| Raven's matrix (standardized) | 0.07 | 0.05 | 0.06 | 0.15 | 0.13 | 0.14 |
| | (0.07) | (0.06) | (0.06) | (0.07)** | (0.07)** | (0.07)** |
| Digit recall (standardized) | -0.02 | -0.03 | -0.03 | -0.04 | -0.05 | -0.06 |
| | (0.07) | (0.07) | (0.07) | (0.07) | (0.07) | (0.07) |
| Seconds to finish mazes | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| (standardized) | (0.07) | (0.07) | (0.07) | (0.07) | (0.07) | (0.07) |
| Combined language score | 0.02 | 0.04 | 0.05 | 0.01 | 0.03 | 0.04 |
| (standardized) | (0.07) | (0.07) | (0.07) | (0.07) | (0.07) | (0.07) |
| ***Small Stakes Risk Aversion*** | | | | | | |
| Percentage Invested in Risky Asset | 0.79 | 0.81 | 0.66 | 0.51 | 0.54 | 0.39 |
| (out of 100 Ksh) | (0.23)*** | (0.23)*** | (0.24)*** | (0.24)** | (0.24)** | (0.25) |
| ***Asset Ownership, and Formal Sector Income*** | | | | | | |
| Owner or spouse has | -0.04 | 0.00 | -0.03 | -0.15 | -0.12 | -0.14 |
| a formal sector job | (0.18) | (0.17) | (0.17) | (0.18) | (0.18) | (0.18) |
| Log (acres land owned + 1) | 0.03 | 0.07 | 0.08 | 0.02 | 0.05 | 0.06 |
| | (0.08) | (0.08) | (0.08) | (0.09) | (0.09) | (0.09) |
| Log (value of durable goods and | 0.25 | 0.22 | 0.22 | 0.21 | 0.17 | 0.17 |
| animals owned + 1) (in 10,000 Ksh) | (0.13)* | (0.13)* | (0.13)* | (0.13)* | (0.13) | (0.13) |
| ***Financial Access*** | | | | | | |
| Has bank account | | 0.19 | 0.20 | | 0.27 | 0.29 |
| | | (0.13) | (0.13) | | (0.14)** | (0.14)** |
| Participates in ROSCA | | -0.48 | -0.48 | | -0.50 | -0.49 |
| | | (0.12)*** | (0.12)*** | | (0.12)*** | (0.12)*** |
| Would like to borrow more money but | | 0.00 | 0.01 | | -0.02 | -0.01 |
| is unable to get it | | (0.11) | (0.11) | | (0.12) | (0.12) |
| ***Time Preferences, Attitudinal Measures, and Financial Recordkeeping*** | | | | | | |
| "Patient:" Prefers 55 Ksh or less | | | -0.05 | | | 0.20 |
| in 1 month to 40 Ksh today | | | (0.27) | | | (0.28) |
| Time Consistent | | | -0.04 | | | -0.12 |
| | | | (0.14) | | | (0.14) |
| Present-biased | | | -0.40 | | | -0.26 |
| | | | (0.17)** | | | (0.18) |
| Patient now, impatient later | | | -0.31 | | | -0.17 |
| | | | (0.30) | | | (0.31) |
| Work Importance Index | | | 0.64 | | | 0.56 |
| | | | (0.27)** | | | (0.28)** |
| Always keeps financial records | | | 0.25 | | | 0.27 |
| | | | (0.12)** | | | (0.12)** |
| Mean of dependent variable | 11.97 | 11.97 | 11.97 | 10.89 | 10.89 | 10.89 |
| Std. dev. of dependent variable | 1.06 | 1.06 | 1.06 | 1.09 | 1.09 | 1.09 |
| Observations | 380 | 380 | 380 | 380 | 380 | 380 |
| R-squared | 0.10 | 0.14 | 0.18 | 0.09 | 0.14 | 0.17 |

Notes: Dependent variables in (log) Kenyan shillings. To avoid dropping observations, we create dummy variables for having missing information for a given variable and code the underlying variable as a 0 when it is missing. Regressions also include for gender, marital status, and literacy. Standard errors in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

**Table 4. Correlates of Profits**

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| | Log Profits in Past 30 Days | | | | |
| ***Background Characteristics*** | | | | | |
| Years of Education (tens of years) | 0.17 | 0.12 | 0.08 | 0.27 | 0.20 |
| | (0.27) | (0.28) | (0.27) | (0.21) | (0.22) |
| Years Shop Open (tens of years) | 0.06 | 0.08 | 0.09 | -0.02 | -0.05 |
| | (0.14) | (0.14) | (0.14) | (0.11) | (0.12) |
| Age | -0.02 | -0.02 | -0.01 | -0.01 | -0.01 |
| | (0.01)** | (0.01)* | (0.01) | (0.01) | (0.01) |
| ***Cognitive Measures*** | | | | | |
| Math score (standardized) | 0.32 | 0.32 | 0.32 | 0.16 | 0.23 |
| | (0.09)*** | (0.09)*** | (0.09)*** | (0.07)** | (0.07)*** |
| Raven's matrix (standardized) | -0.13 | -0.13 | -0.06 | -0.03 | -0.11 |
| | (0.09) | (0.09) | (0.09) | (0.07) | (0.07) |
| Digit recall (standardized) | 0.13 | 0.11 | 0.12 | 0.00 | -0.01 |
| | (0.09) | (0.09) | (0.09) | (0.07) | (0.08) |
| Seconds to finish mazes | 0.15 | 0.15 | 0.15 | 0.10 | 0.07 |
| (standardized) | (0.09) | (0.09) | (0.09)* | (0.07) | (0.07) |
| Combined language score | 0.08 | 0.11 | 0.07 | 0.03 | 0.05 |
| (standardized) | (0.09) | (0.09) | (0.09) | (0.07) | (0.07) |
| ***Small Stakes Risk Aversion*** | | | | | |
| Percentage Invested in Risky Asset | 0.79 | 0.80 | 0.70 | 0.17 | 0.23 |
| (out of 100 Ksh) | (0.32)** | (0.32)** | (0.32)** | (0.25) | (0.26) |
| ***Asset Ownership, and Formal Sector Income*** | | | | | |
| Owner or spouse has | 0.17 | 0.18 | 0.03 | 0.13 | 0.22 |
| a formal sector job | (0.24) | (0.24) | (0.24) | (0.19) | (0.20) |
| Log (acres land owned + 1) | 0.07 | 0.10 | 0.11 | 0.08 | 0.06 |
| | (0.11) | (0.11) | (0.11) | (0.08) | (0.09) |
| Log (value of durable goods and | 0.16 | 0.11 | 0.10 | 0.01 | 0.06 |
| animals owned + 1) (in 10,000 Ksh) | (0.16) | (0.17) | (0.17) | (0.13) | (0.13) |
| ***Financial Access*** | | | | | |
| Has bank account | | 0.25 | 0.23 | -0.02 | -0.09 |
| | | (0.18) | (0.17) | (0.14) | (0.14) |
| Participates in ROSCA | | -0.20 | -0.19 | 0.08 | 0.01 |
| | | (0.16) | (0.15) | (0.12) | (0.13) |
| Would like to borrow more money but | | -0.13 | -0.15 | -0.13 | -0.09 |
| is unable to get it | | (0.15) | (0.14) | (0.11) | (0.12) |
| ***Time Preferences, Attitudinal Measures, and Financial Recordkeeping*** | | | | | |
| "Patient:" Prefers 55 Ksh or less | | | -0.81 | -0.33 | -0.54 |
| in 1 month to 40 Ksh today | | | (0.37)** | (0.29) | (0.30)* |
| Time Consistent | | | 0.08 | -0.13 | -0.06 |
| | | | (0.19) | (0.15) | (0.16) |
| Present-biased | | | -0.11 | 0.15 | 0.08 |
| | | | (0.20) | (0.16) | (0.16) |
| Patient now, impatient later | | | -0.84 | -0.31 | -0.42 |
| | | | (0.45)* | (0.34) | (0.36) |
| Work Importance Index | | | 0.74 | 0.40 | 0.55 |
| | | | (0.38)* | (0.29) | (0.31)* |
| Always keeps financial records | | | 0.36 | 0.16 | 0.16 |
| | | | (0.16)** | (0.13) | (0.14) |
| ***Inventory*** | | | | | |
| Log Total Inventory | | | | 0.58 | |
| | | | | (0.06)*** | |
| Log Inventory on Top 13 Items | | | | | 0.52 |
| | | | | | (0.06)*** |
| Mean of dependent variable | 9.62 | 9.62 | 9.62 | 9.61 | 9.61 |
| Std. dev. of dependent variable | 1.00 | 1.00 | 1.00 | 0.97 | 0.97 |
| Observations | 188 | 188 | 188 | 184 | 184 |
| R-squared | 0.17 | 0.19 | 0.27 | 0.56 | 0.51 |

Notes: Dependent variables in (log) Kenyan shillings. To avoid dropping observations, we create dummy variables for having missing information for a given variable and code the underlying variable as a 0 when it is missing. Regressions also include for gender, marital status, and literacy. Standard errors in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

**Table 5. Correlates of Survival**

| | (1) | (2) | (3) |
|---|---|---|---|
| | Shop still open in May 2011 | | |
| ***Background Characteristics*** | | | |
| Years of Education (tens of years) | 0.02 | 0.03 | 0.02 |
| | (0.04) | (0.04) | (0.04) |
| Years Shop Open (tens of years) | 0.04 | 0.03 | 0.04 |
| | (0.02)* | (0.02)* | (0.02)* |
| Age | 0.00 | 0.00 | 0.00 |
| | (0.01) | (0.01) | (0.01) |
| ***Cognitive Measures*** | | | |
| Math score (standardized) | 0.00 | 0.00 | 0.00 |
| | (0.01) | (0.01) | (0.01) |
| Raven's matrix (standardized) | 0.02 | 0.02 | 0.03 |
| | (0.01)* | (0.01)* | (0.01)* |
| Digit recall (standardized) | 0.00 | 0.00 | 0.00 |
| | (0.01) | (0.01) | (0.01) |
| Seconds to finish mazes | 0.02 | 0.02 | 0.02 |
| (standardized) | (0.01) | (0.01) | (0.01) |
| Combined language score | -0.01 | -0.01 | -0.02 |
| (standardized) | (0.01) | (0.01) | (0.01) |
| ***Small Stakes Risk Aversion*** | | | |
| Percentage Invested in Risky Asset | -0.13 | -0.13 | -0.16 |
| (out of 100 Ksh) | (0.05)*** | (0.05)*** | (0.05)*** |
| ***Asset Ownership, and Formal Sector Income*** | | | |
| Owner or spouse has | -0.03 | -0.03 | -0.02 |
| a formal sector job | (0.03) | (0.03) | (0.03) |
| Log (acres land owned + 1) | -0.01 | -0.01 | -0.01 |
| | (0.02) | (0.02) | (0.02) |
| Log (value of durable goods and | 0.02 | 0.02 | 0.01 |
| animals owned + 1) (in 10,000 Ksh) | (0.03) | (0.03) | (0.03) |
| ***Financial Access*** | | | |
| Has bank account | | -0.01 | -0.01 |
| | | (0.03) | (0.03) |
| Participates in ROSCA | | -0.01 | -0.01 |
| | | (0.02) | (0.02) |
| Would like to borrow more money but | | -0.02 | -0.02 |
| is unable to get it | | (0.02) | (0.02) |
| ***Time Preferences, Attitudinal Measures, and Financial Recordkeeping*** | | | |
| "Patient:" Prefers 55 Ksh or less | | | -0.04 |
| in 1 month to 40 Ksh today | | | (0.06) |
| Time Consistent | | | 0.00 |
| | | | (0.03) |
| Present-biased | | | 0.06 |
| | | | (0.04) |
| Patient now, impatient later | | | -0.01 |
| | | | (0.07) |
| Work Importance Index | | | 0.07 |
| | | | (0.06) |
| Always keeps financial records | | | 0.04 |
| | | | (0.03) |
| Mean of dependent variable | 0.91 | 0.91 | 0.91 |
| Std. dev. of dependent variable | 0.28 | 0.28 | 0.28 |
| Observations | 700 | 700 | 700 |
| R-squared | 0.04 | 0.04 | 0.05 |

Notes: To avoid dropping observations, we create dummy variables for having missing information for a given variable and code the underlying variable as a 0 when it is missing. Regressions also include for gender, marital status, and literacy. Standard errors in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1%, respectively.

**Table A1. Summary Statistics for Sample of Shops with Survival Data**

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | | | Quantiles | | | |
| | Mean | Std. Dev. | 25th | 50th | 75th | 90th |
| ***Inventories, Profits, and Credit to Customers*** | | | | | | |
| Total survival | 26.64 | 29.75 | 8.00 | 15.00 | 30.00 | 70.00 |
| survival in Top 13 Items | 9.47 | 11.38 | 2.83 | 5.17 | 10.82 | 25.01 |
| Profits in past month | 2.47 | 2.87 | 0.80 | 1.20 | 3.43 | 6.00 |
| Gives out credit to customers | 0.91 | - | - | - | - | - |
| Amount given out in credit in past month | 1.11 | 5.72 | 0.10 | 0.20 | 0.45 | 1.50 |
| ***Background Characteristics*** | | | | | | |
| Years of Education | 10.51 | 3.35 | 8.00 | 11.00 | 12.00 | 16.00 |
| Years Shop Open | 6.56 | 5.89 | 2.16 | 4.88 | 9.30 | 14.24 |
| Male | 0.52 | - | - | - | - | - |
| Married | 0.80 | - | - | - | - | - |
| Age | 33.42 | 9.57 | 27.00 | 32.00 | 38.00 | 46.00 |
| Can Read and Write (Swahili) | 0.97 | | | | | |
| ***Asset Ownership and Formal Sector Income*** | | | | | | |
| Owner or spouse has a formal sector job | 0.15 | - | - | - | - | - |
| Acres land owned | 1.97 | 2.92 | 0.00 | 1.00 | 2.50 | 4.00 |
| Value of durable goods and animals owned | 10.83 | 14.29 | 3.97 | 6.56 | 11.35 | 19.88 |
| ***Financial Access*** | | | | | | |
| Has bank account | 0.82 | - | - | - | - | - |
| Participates in ROSCA | 0.43 | - | - | - | - | - |
| Would you like to borrow more money but are unable to get it (percentage "yes") | 0.37 | - | - | - | - | - |
| ***Small Stakes Risk Aversion*** | | | | | | |
| Percentage Invested in Risky Asset | 0.57 | 0.20 | 0.50 | 0.50 | 0.70 | 0.80 |
| ***Time Preferences*** | | | | | | |
| "Patient:" Prefers 55 Ksh or less in 1 month to 40 Ksh today | 0.08 | - | - | - | - | - |
| Time Consistent | 0.18 | - | - | - | - | - |
| Present biased | 0.51 | - | - | - | - | - |
| Patient now but impatient later | 0.05 | - | - | - | - | - |
| Maximally impatient in present and future | 0.25 | - | - | - | - | - |
| ***Attitudinal Measures*** | | | | | | |
| Work Importance Index | 0.35 | 0.19 | 0.25 | 0.25 | 0.50 | 0.50 |
| ***Financial Recordkeeping*** | | | | | | |
| Always keeps financial records | 0.28 | - | - | - | - | - |

Notes: There are 687 shops in the sample. Sample size differs for some variables. All monetary values in 10,000 Kenyan shillings. Exchange rate was roughly 75 Ksh to $1.

## Appendix: Math Questionnaire

| | | |
|---|---|---|
| F_1 | Look at the row of numbers below. What number should come next?<br>8 4 2 1 ½ ¼ ? | \|_____\| |
| F_2 | A notebook costs 21 Ksh for each one. What will four notebooks cost? | \|_____\|<br>Ksh |
| F_3 | How many of the five pairs of items listed below are exactly the same? Circle the same ones.<br>1 Nieman, K.M. Neiman, K.M.<br>2 Thomas, G.K. Thomas, C.K.<br>3 Hoff, J.P. Hoff, J.P.<br>4 Pino, L.R. Pina, L.R.<br>5 Warner, T.S. Wanner, T.S. | \|____\| \|____\|<br>\|____\|<br>\|____\| \|____\| |
| F_4 | Which one of the numbered figures below is most different from the others.? Circle the number.<br>  <br>**1 2 3 4 5** | \|_____\| |

| | | |
|---|---|---|
| F_5 | A bus travels 20 meters in 1/5 second (one fifth of second). At the same speed, how far will it travel in three seconds? | \|_____\| meters |
| F_6 | Rope costs 10Ksh a metre. How many metres can you buy for 60 Ksh? | \|_____\| meters |
| F_7 | Which number in the following group of numbers represents the smallest amount? Circle the smallest.<br>a) 7 b) 2/5 c) 31 d) 1/3 e) 2 | \|_____\| |
| F_8 | A boy is 17 years old and his sister is twice as old. When the boy is 23 years old, what will be the age of his sister? | \|_____\| years old |

| | | |
|---|---|---|
| F_9 | Trousers and a shirt cost 1100Ksh in total. The trousers cost 1000Ksh more than the shirt. How much does the shirt cost? | \|_____\| Ksh |
| F_10 | If it takes 5 machines 5 minutes to make 5 cars, how long would it take 100 machines to make 100 cars? | \|_____\| minutes |
| F_11 | In a lake, there is a patch of water hyacinths. Every day, the patch doubles in size (becomes twice as big). If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake? | \|_____\| days |