Heterogeneity Effects of Development Funding on Microenterprises

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Abstract

This paper focuses on the heterogeneity of firm's characteristics on development funding. It develops a theoretical model under utility maximization framework with imperfect insurance and credit markets constraints, deriving the returns to capital determined by firm's size, structure and entrepreneur's utility form. Empirical evidence from Sri Lanka Microenterprises Project (2005-2010) shows that the returns vary across different quantiles of firm's profits and the ability/risk aversion of entrepreneur affects the returns significantly differently on the distribution of profits. It also summarizes the development funding policy and offers advice on policy evaluation in Sri Lanka.

Key words: Microenterprises, Quantile Regression, Heterogeneity, Development Funding Policy

JEL codes: O16, O53, C21

1 Introduction

As the potential source of growth and employment, microenterprises are essential part of development funding. Microfinance institutions and nongovernmental organizations (NGOs) have recently become the most common source of household enterprises with more than 70 million clients worldwide. A concerning question for policy makers in channels for development funding is how these microenterprises make investment decisions and what characteristics of entrepreneurs affect their profits. Broad field experiments (De Mel, McKenzie and Woodruff (2008) (henceforth DMW), Banerjee and Duflo(2006)) show evidence that return to capital among microenterprises is much higher than market interest rate. However, few empirical evidence have been found in the choice of optimal scales and timing of interventions as well as the evaluation of riskiness from the perspective of policymakers and NGOs in developing countries.

Previous literature on microenterprises in developing countries can be categorized from three perspectives: i) the form of production function; ii) the estimation of the returns to capital; iii) the implications for the functioning of markets. Ackerberg, Benkard, Berry, and Pakes (2007) points out the absence of plausible instruments with substantial inter-firm variation, while DMW's approach advances the related literature on instrumental variables estimates of production functions by giving randomly selected firms lump sum of money or physical materials or capital. They use these random grants as instruments for capital in the production function. Banerjee and Duflo (2009) have shown that with perfectly functioning capital markets, all firms should have the same risk-adjusted return to capital. Estimating the extent and sectors in which this prediction does not hold true may then inform us of the extent of capital market imperfections in the broader economy.

Theoretical literature on poverty trap postulates that entrepreneurs might remain inefficiently small for some period of time, but would be able to grow by reinvesting profits. However the argument is in absence of minimum scale and lack of practical policy suggestions. How to maintain a longer-range future for microenterprises is critical for policy designers under the rapid urbanization in developing countries. Tracking the growth pattern of small-scale entrepreneurs provides quantitative analysis on the best time and amount for development funding to support. Therefore by investigating the growth path of returns to capital generated by random investment, we find that the returns to development funding vary across microenterprises in DMW Sri Lanka field experiment.

There is a broad literature on heterogeneous return to human capital (Tazeen Fasih et al (2012)) while due to the complexity of capital markets, there are few papers concentrating on the heterogeneity of returns to capital. Different from previous literature, we investigate how entrepreneurs make investment decisions and operate microenterprises in developing countries. It concentrates on the heterogeneity of microenterprises, such as the initial capital endowment, the entrepreneur's ability and risk awareness.

This paper aims at measuring the effects caused by heterogeneity and therefore evaluating the investment intervention. How nongovernmental organizations (NGOs) and private/state-run financial institutions can best design cost-effective interventions for microenterprises is relevant to improving access to credit and offering more investment opportunities in developing countries. Therefore we explore the optimal scale of capital stock for interventions in order to determine the peak effectiveness of investment funding policy.

From the firm's perspective, there are a list of distorting factors affecting the growth of microenterprises such as government policies, credit market failures, intro-family inefficiencies, learning externalities, and even behavioral factors. It's hard to conclude that the particular distortion has resulted in a significant loss in productivity even if the prima facie evidence is the strongest (Banerjee and Duflo (2004)). It comes into an essential issue that how the microenterprises use the development funding efficiently and what kind of policy micro finance institutions should stick to.

From the econometrics view, the panel data embeds different firm's profits in different time periods. Different firm's benefit from a certain amount of increase in capital stock may be different due to heterogeneity of firms and entrepreneur's characteristics (Karlan and Zinman (2010)). To separate these heterogeneity effects can help: 1) the comparison between long-run and short-run effects of capital shock for a single average firm from the panel data set; 2) the character of firms which benefit most from such capital shock or obtain higher profit increment from the inventions. Therefore this paper introduces quantile methodology in analyzing the heterogeneity effects in development funding.

Evaluating the microenterprises before issuing funding is essential for microfinance organizations and better helps entrepreneurs set up longer-term improvements. Education level, intelligence ability and gender of the entrepreneurs affect the management of the microenterprises. Risk aversion of entrepreneurs and uncertainty of projects are main factors characterizing the riskiness of enterprises. How these characteristics affect the returns to capital offers specific measurements of the desirable quality of entrepreneurs for policymakers. The characteristics corresponding to higher return rate are attractive to lenders in practice. This paper also shows evidence of nonlinear effects of risk aversion and uncertainty in the imperfect financial markets.

As is pointed by Karlan and Morduch (2009), one way in which access to funding may promote economic development is by providing some poor individuals the opportunity to set up their own businesses. Evaluating the microenterprises before issuing funding is essential for microfinance organizations and better helps entrepreneurs set up longer-term improvements, as well as providing feedback to microfinance policies applied to imperfect markets.

The paper is structured as follows. Section 2 outlines the theoretical model of household firm problem under imperfect credit market. The model serves as the foundation of the econometric

regression and generates the sources of heterogeneity effects. Section 3 applies quantile regression to the DMW dataset and discusses the returns to capital in terms of different quantiles of the sample. The empirical econometric model, based on the model in previous section, sheds light on entrepreneur's characteristics effect towards the capital shock on microenterprises' profit. Section 4 connects the empirical results with policy analysis, especially focusing on the current situation in developing countries such as Sri Lanka. Section 5 concludes and provides an outlook on future work. All figures and tables are in the end.

2 Theoretical Models

2.1 Model setup

The baseline theoretical model is a one-period household production model. Household has a constant relative risk aversion (CRRA) utility function:

$$U(C, \bar{L} - L) = \frac{C^{1-\gamma} - 1}{1-\gamma} + (\bar{L} - L)^{\sigma}$$

He has $\bar{L}$ hours to allocate between operating the microenterprise L and leisure $\bar{L} - L$. For simplicity, assume there is no outside labor market and households don't hire employees. He also has initial asset holding A and can borrow B from the formal credit market. There is a borrowing limit $\bar{B}$ for the household. The utility function is separable in consumption and leisure, $U_{lc}'' = U_{cl}'' = 0$. γ measures the household relative risk aversion coefficient.

There is a single technology in the traditional Cobb-Douglas form:

$$f(K, L, \theta) = \theta K^{\alpha} L^{\beta}$$

K is the capital amount that household invests in his small business. θ represents the technology shock and $\alpha + \beta$ measures the returns to scale level of the microenterprise. The household also faces a production risk ε and receives $\varepsilon f(K, L, \theta)$ from production. ε is a random variable with mean 1 and standard deviation η. In addition, we make the standard assumption that there are a fixed number of households in this economy and each firm needs one household to operate and manage. The market rate of return to capital is r.

2.2 Household problem

Household's problem is to choose the amount of capital stock K, financed through both formal credit market and internal household capital market, the labor devoted to the microenterprise L. The household's maximization problem is

$$max_{\{K,L\}} E_{\varepsilon}[U(C, \bar{L} - L)]$$

$$s.t. \;\; C = \varepsilon f(K, L, \theta) - rB,$$

$$K = A + B, B \leq \bar{B}, L \leq \bar{L}$$

A is given as the household internal net assets holding. B is the amount of borrowing from the formal credit market, paid back at the market rate r. Borrowing constraint $\bar{B}$ is exogenously determined by the credit market. The first order conditions, derived from the Lagrange method, are

$$f_K(K, L, \theta) = \frac{1}{1 + Cov(U_c, \varepsilon)/E[U_c]}(r + \frac{\lambda}{E[U_c]})$$

$$f_L(K, L, \theta) = [\sigma(\bar{L} - L)^{\sigma-1} + \mu]/E[\varepsilon \cdot U_c]$$

$\lambda > 0$ is the Lagrange multiplier. It represents the tightness of overall credit market constraints. It is the shadow cost of capital from the credit market borrowing. Based on the first order conditions above, λ depends on the household initial asset A and the production function form. Note that $E(\varepsilon) = 1$ meaning production function is a one-to-one mapping with all risk hedged. $f_K(K, L, \theta)$ and $f_L(K, L, \theta)$ are the marginal productivity of capital and labor respectively. U_c denotes the marginal utility of consumption.

2.2.1 Perfect insurance market with missing credit market

Under the assumption of perfect insurance market with missing credit market, production risks can be fully insured by insurance. $\varepsilon = 1$. The model indicates that the returns to capital are implicitly a nonlinear function of household's initial wealth, labor supply and the productivity properties of the microenterprise.

Consider the simple case with binding borrowing constraint. The household will use all they can borrow to invest in the capital. The tightness of overall credit market constraint is strictly positive as there is a strict restriction for the household to borrow in the credit market. The higher the credit market tightness measure is, the more restrictive the credit market is.

Assuming there is an interior solution of interest for labor supply. Then the household allocates labor and leisure when the marginal benefit from working equals to the marginal cost of giving up leisure. In this case the equilibrium can be solved explicitly. We can see capital investment is based only on the initial wealth and the constraint in the credit market.

Entrepreneur's characteristics such as risk aversion and labor-leisure elasticity affect the household's (as an entrepreneur) labor decision, which relates to the tightness measure of the credit market. Such underlying heterogeneity shows in the labor-leisure equality. It has a nonlinear effect on households' decision of working labor.

2.2.2 Perfect credit market with perfect insurance market

When the borrowing constraint is not binding, we have a perfect credit market with the Lagrange multiplier zero. Suppose the household decides the labor supply based on the capital investment and capital-labor ratio is constant in the equilibrium. This assumption indicates that household's

effort depends on the scale of the firm. Large firms have more capital investment therefore also require more labor input. Linear labor supply in terms of capital indicates, as in the ideal case with Cobb-Douglas production function, labor and capital have the equal impact on the production. In a constant return to scale production function, the log of the capital return is a linear function of log capital. Without this parameter condition on the returns to scale, such linear relationship no longer holds.

The capital/labor ratio is independent from the production technology. In a reduced log form, heterogeneity of household characteristics, such as entrepreneur ability, initial wealth and risk aversion, affect the labor and capital investment so as to the returns. We can see that even in a perfect insurance and credit market, heterogeneity of households influences the capital accumulation in a nonlinear way. The underlying heterogeneity includes household's initial wealth, entrepreneur's ability (education, risk aversion and gender) as well as technology shocks.

With increasing returns to scale in the production function, the high level of technology does not contribute more to the capital compared with low level of technology initially. It can be explained by the higher cost of equipment and facility investment.

With constant returns to scale (CRS), entrepreneur characteristics and technology has no further effect on the capital accumulation therefore for the returns to capital. CRS production function would generate a constant treatment effect to capital shocks.

With decreasing returns to scale, heterogeneity of advantageous characteristics has a positive effect on the capital accumulation. The market rate of return has a negative effect on capital.

2.2.3 Perfect credit market with missing insurance market

In another extreme case of missing insurance market with perfect credit market, the riskiness random variable ε and the risk aversion coefficient γ affect the equilibrium conditions. The exact form of the first order condition requires further information about the moments of the ε distribution. X is a linear transformation of the riskiness random variable and n relates to the risk aversion of the entrepreneur.

$$f_K(K, L, \theta) = \frac{E(U_c)}{E(U_c \cdot \varepsilon)} r = \frac{E(X^n)}{E(X^{n+1})} r$$

Suppose X has a normal distribution with mean $f - rK + rA > 0$, the moment generation function of X is an exponential function of the mean and variance. Therefore the effect of riskiness on returns to capital is approximately an exponential function under the normal distribution. Regressing on a linear component of riskiness underestimates the heterogeneity effect, leading to insignificant results. Suppose X has an exponential distribution, based on the moment generation function, the effect of riskiness on returns to capital can be estimated by the multiplication of riskiness and inverse of household risk aversion. In both cases, the covariance

between marginal utility and production risk is more relevant in explaining the imperfectness of insurance market.

3 Empirical Models

Enlightened by the theoretical analysis, the choice of the dependent variables in the econometrics models is made as follows. First, it suggests the heterogeneity of returns across households might come from the inconstant returns to scale in the production function or the tightness of the credit market. Constant return to capital is based on the assumption of constant return to scale production function and perfect credit market. OLS IV coefficient estimates the average returns to scales while quantile regression tells the median, quarter and even 10 percentile estimators of returns. Quantile regression offers the distribution of returns in terms of profit quantiles and tests the return to scale of the sample.

Second, the regression is in log forms and linear to initial wealth. Heterogeneity effects are in terms of different quantiles of initial profits. Take the log of profits and regress on the IV treatment variable as well as the characteristics of firms. Firm's initial wealth is proportional to the initial capital endowment. The baseline model treats the firm's initial profit report as the capital endowment.

Third, the underlying heterogeneity includes household labor supply, household ability to make decision, household risk aversion and labor-leisure evaluation. There is no explicit formula for the effects in the model while it suggests these parameters affect the profit simultaneously. The quantile regression includes the number of wage workers in the firm, the ability, risk aversion and education, gender of entrepreneurs.

Last but not least, it suggests a test of imperfect insurance market by adding exponential terms of riskiness and interacting measures of the inverse of risk aversion with uncertainty of business returns. It's of interest to add the intersection of treatment instrument and the entrepreneur characteristics. This separates the heterogeneity effects between the treatment group and the control group. By comparing the differences in the corresponding coefficients, we can learn the propagation of capital investment from different characteristics of microenterprises.[1]

The empirical analysis is based on the unique data set of the DMW field experiment. The field experiment is carried out in Sri Lanka. It fits well to the goal of the paper to make contribution to the development funding in emerging markets. The data is obtained from the World Bank research team of Sri Lanka Microenterprise Project 2005-2007.

3.1 Microfinance in Sri Lanka

[1] The econometric model aims at individual firm level and doesn't take the group effects in the microfinance literature. It avoids peer effects and learning benefits for simplicity.

The microfinance movement in Sri Lanka dates as far back as 1906 with the establishment of Thrift and Credit Co-operative Societies (TCCSs) under the Co-operative Societies Ordinance introduced by the British colonial administration. Following the tsunami which struck Sri Lanka in 2004, there was an influx of foreign aid to the country, of which a substantial amount was channeled to the microfinance sector. While many donors worked through established micro finance institutions, some funded the establishment of multi-sectorial livelihood programs which included microfinance components. These were largely unsustainable in the long-term. They had some detrimental effects on the sector in the short term through their mix of grants and subsidized loans and the resulting damage done to the established credit culture.

There is a recent emerging trend: the entry of commercial banks and registered finance companies and other large corporate entities into the micro finance business.[2] For many commercial banks and finance companies, microfinance is more a Corporate Social Responsibility (CSR) or image building activity. The absence of a cohesive regulatory and supervisory system for the microfinance sector is one of the barriers to the future growth of the sector. The methods and standards of supervision vary widely and the absence of a single regulatory and supervisory authority has resulted in the lack of uniform standards and development of a common direction.

Microfinance Institutions (MFIs) are required to obtain a license and expected to meet certain capital requirements depending on their scale of operations under the MFI Act proposed by Central Bank of Sri Lanka (CBSL). Microfinance is currently classified as a money lending business and therefore restricted from obtaining offshore equity investment into such business, which has a negative impact on a number of large, better performing, unregulated MFIs which could not scale up operations through offshore equity capital.

The attempt to introduce a regulatory and supervisory system for the microfinance sector has been going on for a number of years. There are concerns over some provisions in the MFI act released by CBSL, which has been withheld for restructuring and amendment at this time of writing. This paper is written from the perspective of regulations and supervisions of microfinance development under the above background in Sri Lanka.

3.2 Data and summary

The data is based on the random field experiment carried in Sri Lanka. It's collected from Sri Lanka Microenterprise Project (2005-2010) by De Mel, McKenzie and Woodruff. This field experiment was originally designed to study the returns to capital in microenterprises and the process of recovery of microenterprises from the December 2004 tsunami, carried out in three Western and Southern districts of Sri Lanka: Kalutara, Galle and Matara. The baseline survey was carried out in April 2005, with microenterprises re-interviewed quarterly.

[2] Base on the 2009 Microfinance Industry Report of Sri Lanka.

The door-to-door screening survey of households was used to identify enterprises with invested capital of 100,000 Sri Lanka Rupees (LKR) (about 100 USD) or less, excluding investments in land and buildings. There are 618 enterprises in retail trade and manufacturing operated by owners aged 22 to 65, and with no paid employees. The microenterprises include common self-employment activities such as running small grocery stores, selling tea, food preparation, sewing clothes, making lace products, and coir production. They therefore cover a range of typical small-scale activities in many developing countries.

To rule out the effect of 2004 tsunami, this paper focuses only on the 408 enterprises located away from the boundary. The selected enterprises are either in industries less affected by the weather or based on the geography location. The lack of record keeping suggests that reported profits may be subject to a range of different types of measurement error. However, though the lack of record keeping is a general phenomenon among small businesses in developing countries, there is still ways to determine what can be done to elicit reasonable information on profits from small firm owners.[3]

From the sample profit distribution of nine waves starting from April, 2005 to April, 2007 (Figure 1), we can postulate the effects of capital investment shocks on profits are different for different scales of microenterprises in terms of profits. Wave 1 is the baseline sample and the histograms include all the available observations. Though the treatment effects are noisy in the figure, it shows unbalanced growth rate across different sizes of the firms. In addition, the sample is not normally distributed in profits. Rather than the ordinary least square regression, it's better to choose quantile regression in analyzing the returns of capital. Tracking the capital accumulation process across different firms in terms of profit quantiles helps establish a cost effective policy for development funding.

Table 1 summarizes the characteristics of the enterprise owners and their firms. It displays the baseline survey characteristics of firms in different percentiles. The median owner in the sample is 41 years old and has 10 years of education. The sample is almost equally divided between male and female owners. The coefficient of relative risk aversion comes from a lottery B game collected in the second wave of the survey. Respondents were asked whether they would choose a certain payoff of 40 LKR (about two hours of mean reported earnings) or a gamble with payoffs of 10 or 100 LKR. The CRRA is calculated from the switchover point from the certain payoff to the gamble. Randomization was done by computer so any differences between the treatment and control groups are purely due to chance.

From the comparison between density of profits and corresponding capital stock, we see the benefits from investment are not a monotone linear function of capital stock. There might be first an increasing in profits driven by capital increment while effects diminish as firm size enlarges. From the theoretical model, there is a relative optimal proportion of investment increment to

[3] Refer to de Mel et al. 2009 for more details on data collecting process.

capital stock when the enterprises are in its best growth path. Therefore we apply the quantile regression method to obtain the heterogeneity effects in different quantile of profits and generate the distribution of effects on returns to capital.

3.3 Quantile regression

Quantile regression is applied in order to investigate the relationship between capital stock shocks and a set of predictors, such as: the number of waged workers, the entrepreneurial ability, the owner's risk aversion, the years of education of the entrepreneur, and the gender of the entrepreneur. Different from the ordinary least square regression addressing the question "*does the capital shock matter*"[4], quantile regression focuses on answering another important question "*how does the capital investment shock affect microenterprises' profits at different quantiles*".

This section shows the distribution of the heterogeneity effects of the predictors across firms. The response variable is distributed based on the profits of the microenterprises in the pre-treatment baseline survey. Quantile regression specifies changes in the quantiles of the response variable. It also provides evidence of the heterogeneity of treatment effects separately from the treatment effects of the returns from the scale of the production function form.

3.3.1 The predictors of concerns

Based on the theoretical model, the predictors reflect the heterogeneity of microenterprises characteristics. Variables and explanations are as follows:

1. *Evertreat* represents the dummy variable of random capital shock in the first wave of the survey. As the property of randomization in the field experiment, it is used as an instrument variable (IV) of capital investment shock. The coefficient of this IV measures the treatment effect of returns to capital.

2. *Number of workers* is the number of paid wage workers in the household in the pre-treatment baseline survey. It reflects the labor supplies of household and negatively correlated with the wages. The elasticity of labor supply is also considered in the extension of the model.

3. *Ability: Digit span recall maximum* follows Djankov et al. (2005) and represents the score of the entrepreneur on a forward digit span recall test. Households were shown a three digit number. The card showing the number was then taken away. Ten seconds later, respondents were asked to repeat the number as written on the card. Those responding correctly were shown a four digit number, and so forth up to 11 digits. The mean digit span recalled was 5.9 digits. This can be used as a measurement of entrepreneurial ability.

[4] De Mel et al. (2008) has shown that the real return to capital in these enterprises, on average, is 4.6%-5.3% per month (55%-63% per year), substantially higher than market interest rates. However, they treated the return to capital as a constant for all firms.

4. *Relative Risk Aversion by lottery B* is collected from experiments played with real money with each firm owner. Firm owners were given the choice between 40 LKR (1 US dollar= 128.55 Sri Lanka rupees) for certain, or a gamble with *x* percent chance of 10 rupees and (100-*x*) percent chance of 100 rupees. A 10-sided dice was used to vary odds of the higher payment from 10 percent up to 90 percent. The probability threshold at which an individual switches from the safe payment to the risky gamble provides a measure of risk aversion. The midpoint of the implied CRRA interval is used as the measure of risk aversion.

5. *Years of Education of entrepreneur* represent the most standard characteristics of the enterprise owner (Paulson and Townsend 2004). The average years of education are 9.0 years with a standard deviation of 3.1 years.

6. *Gender* is the gender of the entrepreneur. The proportion of female entrepreneurs is 0.491 in the baseline data set.

3.3.2 Regression model

In order to estimate the heterogeneity effects in quantiles, we write the regression model of the following form:

$$y_{it} = \alpha_i + \beta_i S_{it} + z_{it} D_{it} + \gamma_t + \mu_{it}$$

y_{it} is the real profit in log of enterprise i at wave t. S_{it} is a vector gathering other determinants of firm profits. These determinants include the number of waged workers and characteristics of entrepreneurs, such as gender, age, years of education, and the relative risk aversion coefficient. D_{it} is the treatment (capital shock) status of enterprise i at wave t. $D_{it} = 1$ indicates that the enterprise is receiving a random increase in capital stock in the field experiment.

α_i is the fixed effect at the microenterprise level. It accounts for the unobserved microenterprise characteristics. β_i is a vector of the corresponding effects, representing firm-specific heterogeneity effects of the observed entrepreneur characteristics. It measures the development quality of the microenterprises. z_{it} is the treatment effect which can be interpreted as the returns to capital. γ_t is the fixed effect at the wave level[5]. μ_{it} is the error term.

This model can be interpreted as a production function of microenterprises. The production technology is represented by firm-specific characteristics, which are supposed to stay constant between waves. Since the capital shock is carried out as a random capital/cash prize in this field experiment, these parameters are uncorrelated with the treatment status.

First difference methodology is not applicable to this particular dataset. Because the microenterprises' level of profits are comparatively small and the progress of development is

[5] Different from the first difference model, this model takes the time trend as another dimension of fixed effect rather than adding lags in profits. The regression is based on the related DMW literature and the goal of the analysis is to investigate the heterogeneity of entrepreneurs' characteristics.

small as well. Therefore we use the fixed effect quantile regression model to see the different effects across distributions. The fixed effects include the firm level and wave level[6].

A common concern when estimating any type of production function is that there can be feedback effects on the choice of inputs. The chosen independent variables gather determinants of profits that present between-wave variation while the gender of the entrepreneur, the age of the entrepreneur, education level, and the hourly wage rate paid to the households stays unchanged in such a short term period. To allow for heterogeneity and avoid other noise, we focus on enterprises at the first 3 waves in the field experiment[7].

3.3.3 Results

Results of the quantile regression are shown in Table 2 and Figure 2. We find significant evidence of nonlinearity in Table 2. Compared with OLS results, quantile regression suggests the treatment effects vary differently in different quantiles. The returns to capital at the 0.25 and 0.75 quantiles are significant positive while the median and both tails are not significant from zero. For microenterprises, the number of worker hired has a negative impact on the real profits regardless of the quantiles. The results of ability measure show that there is a significant negative impact of the micro-entrepreneur's ability for the 0.75 quantile. Female entrepreneur leadership affects microenterprises' return constantly and risk awareness of entrepreneur help them better grow.

The horizontal axis in Figure 2 represents different quantiles of firm's profits in the pre-treatment baseline survey. The vertical axis represents the effects of predictors on capital stock. In the top left of the figure, the treatments of capital stock shocks have the expected positive effects on capital stock, and the effects are roughly proportional to the size of the treatment for the 0.8 quantile of the sample.

At the median, the effect of the shocks on capital stock is approximately 120%–130% of the treatment amount. The number on the vertical line represents the treatment effect in percentage of the increment in capital flows. For firms with higher capital stock, especially in the upper 20% of the sample, capital shocks have tremendous effect on firm's profits. In the top middle of the figure, the effect of numbers of wage workers is always negative and decreases for larger enterprises.

From the theoretical point of view, the slope of the curve equals to the marginal revenue minus wage rate. This non-convex curve shows that large firms pay higher wages and heterogeneity in wages dominates the impact on profits and capital stocks. There might exist an overpaid problem for large firms since for the quantile above 0.8, the marginal cost of hiring one more worker is more than ten times the treatment amount (10,000 LKR, which is less than 100 USD). One of the

[6] The quantile regression is coded in STATA and do file is available upon request.
[7] Note that in the data set, there are 9 waves while the treatment shocks are mainly located in the first 3 rounds.

possible explanations is the regulation cost in developing countries such as training of wage workers. Regulation, especially those aimed at controlling prices and entries into markets that would otherwise be competitive, can limit growth and significantly reduce economic welfare (Hahn and Guasch (2000)).

Developing countries can consider several regulatory policies, tools, and frameworks to improve their approach to regulation. Another explanation is that the type of workers matters in their contribution to the firm's profit. Permanent workers contribute more to the long-term profits while short-term workers have high liquidity of changing jobs. Microenterprises are limited in hiring permanent workers especially for small households.

The entrepreneur's ability shows different tracks of effects in digit span recall and years of education from the figure. The maximum digit span recalled has a U-shape curve across quantiles while from the quantile regression table summary, the negative coefficients for 0.5 and 0.75 quantiles are not significant from zero.

Risk aversion effect supports the statement that more risk aversion entrepreneurs are more reliable therefore can have more access to development funding. There is another impact on risk aversion that more risk aversion entrepreneurs are less likely to make risky investment which might be a potential loss in profits and hinder the growth of the firm. Based on the bottom left graph, the risk awareness influences the entrepreneur's credibility and helps microenterprises grow healthily.

The gender effect results consistently with previous literature. Male entrepreneurs have a relative advantage in operating and managing the firms, especially for large firms[8]. In contrast with insignificant average impact of treatment for female-owned enterprises in DMW, we can see female owners have a significant negative impact on firm's profit for the higher quantiles. In developing countries such as Sri Lanka, the gender difference is still a critical issue on the growth of microenterprises.

There are two possible explanation of the nonlinearity in the returns to capital. One is the exact form of the production function. For firms with increasing returns to scale, the capital shocks take into effect above some threshold as shown in the quantile regression. It's hard for small firms to obtain large machines to improve the technology in a short period of capital accumulation. On the other hand, heterogeneity in entrepreneurs and technology can also affect the profits as capital stock increases. Regulations on capital flows in developing counties will affect firms with different level of capital stock differently.

To separate these two causes of non-convexity in production function, we consider the intersection between treatment dummy of capital shocks and the predictors. We apply the

[8] McKenzie and Woodruff (2006) shows treatment impacts are significantly larger for enterprises owned by males; while there is no positive return in enterprises owned by females.

quantile regression for six parameters: treatment amount, number of wage workers, entrepreneur ability measured by maximum digit span recall, relative risk aversion by lottery B, years of education of entrepreneur, and gender. These dependent variables are chosen based on the theoretical model of entrepreneur production decision making problem.

Table 3 reports the two important effects of interest: treatment effect and coefficient of risk aversion. We can see both the treatment amount and risk aversion have significant positive effect on real profits. However, the effects are not constant for different quantiles. It's intuitive to interpret the results as a consequence of different scales of capital in microenterprises. There is a peak in the effects of capital shocks at 0.8 quantile, representing that for microenterprises in this range of profits level, it's better to give them such capital benefit when they are at the 80% quantile of the log profit distribution.

The effects of number of wage workers are decreasing as the microenterprises grow. The ability of entrepreneurs has a surprising pattern of effects since it reaches a local maximum around the 0.2 quantile. This is in contrary to the effect of education level. For education level and risk aversion, its increasing trend indicates they play an important role in the future extension of the microenterprises. Therefore for a sustainable growth pattern for microenterprises, entrepreneurs should improve their risk awareness and education.

3.3.4 Heterogeneity properties in quantiles

Figure 3 gives a general summary of the distribution of each predictor: digit span (entrepreneur memory ability), relative risk aversion by lottery B, entrepreneur education level, and female verified (entrepreneur gender). The data set is diversified and representative to a wide range of heterogeneity.

Digit span recall maximum has a step figure with respect to normal distribution which matches the analysis of entrepreneur ability. It offers the feasibility of the basic test for the significant effects on profit quantile regression. The relative risk aversion by lottery B varies from -1.48 to 2.47. It follows a monotone pattern with extreme cases at the two boundaries. Years of education of the entrepreneur have an unbalanced step pattern different from the digit span recall ability. There is an upper ceiling for education while there is a possibility that the abilities of this group of entrepreneurs with the same education years are different in firms' management. The gender of the entrepreneur is a balanced dummy variable.

Figure 4 shows plots of characteristics in terms of quantiles of real profits at firm level. We can see most firms' profits are allocated between 0 and 40,000 LKR (approximately 300 USD). Intuitively, the expected results are positive correlation between entrepreneur characteristics and real profits. However, from the graph, it's hard to draw this conclusion for microenterprises in Sri Lanka. Therefore we conduct more accurate quantile regression to explain the relation between returns to capital and entrepreneurs' characteristics.

The ability of entrepreneur is normally distributed with respect to the quantiles of real profits. The risk aversion can be viewed randomly uniformly distributed in the range of real profits. Education level of entrepreneurs follows a positive correlation with profits. The larger the years of education, the higher probability the entrepreneur would get a high profit with. Gender effects are hard to see from the plot but it shows that the sample is balanced in gender of the entrepreneur. As discussed above, it's hard to tell the relationship simply from two dimensional plots of the sample.

Fit the sample with an OLS regression to see the trend. Figure 5 shows the OLS predicted effects of digit span with 95% confidence interval. It has a slightly positive slope with the horizontal line represents the distribution of profits, taking the full sample into account. The significance of ability's impacts on profits might due to the outliers of the special case but it's reasonable to believe high ability generates high profits.

The best choice to rule out that reason is to conduct quantile regression with respect to different small samples. This serves as a sensitivity test of quantile regression. The properties of the sample provide more reliable results for the analysis and prove feasibility of quantile regression. They also shed light on the heterogeneity tests by adding intersections of treatment dummy and entrepreneur characteristics.

3.3.5 Tests of perfectness of markets

As suggested by the theoretical model, we add five intersection elements to the quantile regression. We include the inventory stock in the independent regression.

$$y_{it} = \alpha_i + \beta_i S_{it} + z_{it} D_{it} + \theta_{it} S_{it} \cdot D_{it} + \mu_{it}$$

As shown in the model, the real profits are affected by the capital shocks, initial wealth, labor hired, and entrepreneur ability such as risk aversion and education level. Figure 6 shows the results. We can see the path of number of wage workers, digit span remembered and gender doesn't change much while patterns of both CRRA and education changes from monotone to non-monotone. One interesting result is that the pattern of treatment effects changes as a reflection of the mirror when adding the initial capital inventory. The capital shocks affect the returns for certain quantiles significantly.

Here the interpretation of the coefficients cannot simply represents the pure returns to capital. Though we use the instrumental variable method, treatment effects' coefficient includes returns to capital, labor, as well as intermediate inputs. The quantile regression is implemented as the effects on the conditional distribution at different quantiles of the firms' real profits. The sharp change for the 0.8-1 quantile in profits is due to the small sample size in that part. The analysis would rule out these as outliers and focus mainly on the 0.2-0.8 quantile.

The initial wealth (initial inventory stock) follows a monotonic linear effect similar to the results of theoretical model for one period household in the imperfect credit market. Number of wage workers' coefficients become insignificant compared to previous QR. There is no big change for the ability of digit span remembered. We can see for different quantile, ability acts differently while the intersection parts are not significant from zero.

The interpretation of the figure requires further assumption carefully. For example, the effects of CRRA follow a hump-shape pattern (negative coefficients). The intersection part can stand for the part of effects due to treatment effect. There is an offset when combining the two parts of effects. In general, there is a positive effect of entrepreneur's risk aversion on the real profits of the microenterprises. Years of education looks like a substitute to the digit span recall ability. They are significant, indicating a combined indicator can represent the entrepreneur's ability and has a constant effect on the growth of microenterprises across different quantiles.

Gender follows the same pattern however following the test design, under the treatment of capital shock, the combine of gender and gender-intersection-with-treatment is no longer significant. Without the treatment of grant, gender matters significantly a lot for the real profits of microenterprises, especially for larger quantiles in terms of real profits.

Intersection indicators represent the difference of that indicator's effects on treatment groups and control groups. For the 0.2-0.8 quantiles, four of them are not significant from zero: entrepreneur ability, risk aversion, gender and education level. However, we can see a non-monotonic pattern for the coefficients of number of wage workers. This is an interesting test to give more information about the labor market development of the small firms.

There is a gap of insignificant for the middle group of 0.5-0.8 quantiles while the lower and higher quantiles are both significantly negative from zero. The underlying heterogeneity and mechanism requires more theoretical analysis as well as further strict assumptions on the model. Figure 8 does give a first general picture of the real world but to be more accurate on the results, more research is needed to be done on the dynamic analysis.

4 Policy Analyses

There is a long tradition of informal savings and credit in Sri Lanka. According to the Central Bank, the volume of deposits in the financial system amounts to 1,700 billion in June 2007. A significant saving culture and a large proportion of the population access to financial services are strengths in Sri Lanka. Sri Lanka also has strong financial sector market infrastructure as well as specialized microfinance training emerging.

These are encouraging steps towards formalizing the study of microfinance and introducing international standards and best practices through the involvement of internationally recognized

institutions such as Frankfurt School of Finance and Management. While the standard and quality of training may differ, the recognition of the need to such specialized training differs for the sector.

4.1 Macro level support

A long term vision and policy for microfinance in Sri Lanka is in need. As shown in the previous section, microfinance institutions can come up with a long run contract with microenterprises and do extra survey/ training to entrepreneurs. Such bundle of development help in funding makes the business cycle in a positive sustainable way.

The lack of a regulatory and supervisory framework for microfinance is the major barrier to transformation and scaling-up of many MFIs. The NGO-MFIs operate in a grey zone as they are essentially unregulated and unsupervised. To balance NGOs and MFIs, government's macro regulations play an important role in the future combining with the market power.

4.2 Meso level support

Local commercial funding institutions are reluctant to get involved in microfinance due to their perception that it is a high risk activity. A risk-awareness training program combined with the promotion of microfinance benefits would eliminate such worries and have a long-run reward to the entrepreneurship. Though there are a large number of off-shore microfinance funding agencies available and interested in well-performing MFIs, the restrictive legal environment and the long process of obtaining approval from the Controller of Exchange serve as deterrent factors for many potential off-shore founders.

From the theoretical model, we see the constraints in capital markets influence the growth of microenterprises. Knowledge transformation and information change within sectors offers more learning activities and exposure to regional/international good practices to MFIs.

As shown in the empirical evidence, the credit market in Sri Lanka is imperfect and lack of credit information sharing. As membership of the Credit Information Bureau of Sri Lanka is mandatory for licensed commercial banks, voluntary participation of MFIs is unlikely as there are costs involved which most MFIs are unwilling to incur. How to handle the over-indebtedness and the probability of a high portfolio at risk for MFIs is crucial for the development funding in the long run.

4.3 Micro level support

The quality and skill levels of MFI staffs are important factors in the development funding. Similar to the field experiment conducted in Sri Lanka Microenterprise Survey, the large amount of subsidized funds hides the real sustainability picture of the MFIs as measured by financial self-sustainable. In order to make institutions financially self-sustainable, the returns to financial investments are important in evaluating the project and designing the contract before funding.

How to measure the load recovery rate and avoid providing a misleading perception of portfolio are indeed the most urgent issue to solve.

In the long run, building up a healthy organization culture with transparency and standardization is essential. A stronger focus on cost-efficiency and sustainability fits the market better and it's good to separate microfinance business from community development activities. Improving delivery technologies and reducing transaction costs is urgent to the sustainability of development funding in the very near future.

4.4 Welfare analysis

In development economics, welfare of household has the same importance as the growth rate of the economy. There is always a trade-off between consumption and leisure. The credit constraint, as an indicator of credit market openness, represents the development level in the credit market. In a perfect insurance market with missing credit market, it affects the capital stock decision directly in a linear way and the consumption indirectly with an increasing marginal effect. So the welfare of the household is affected tremendously at the margin, especially for firms with higher initial capital wealth.

Welfare has influence on the confidence level of entrepreneur's investment decision making. It's of interest to see how the positive cycle of development is established and how such effects passes through the characteristics of entrepreneurs. This would be a future research of interest. Cases are even more complicated for theoretical models with labor markets and imperfect insurance/credit markets.

In summary, the imperfectness in the credit market does affect the developing pattern of small firms. Welfare's change is even bigger than capital accumulation. The amplification of such credit constraints drives more attention to the overall development of markets, not only technology development in the production sector but also the corresponding financial market matching the development level.

5 Conclusions

This paper aims at opening the door to connect economic theory to microfinance industry. By analyzing the heterogeneity of effects to returns, it offers a new insight to implement and evaluate development funding contract. Empirical evidence shows the characteristics of entrepreneurs influence the returns to capital in quantiles of microenterprise's real profits.

The previous literature in implementing the returns to capital by instrumental variable of treatment, in deed, is translated in this paper as the general returns to development funding. These include returns to capital, labor as well as intermediate inputs. Therefore separating these effects are still of great interest for further research study.

5.1 Summary

This paper figures out how heterogeneity of entrepreneur characteristics affects the returns to capital shocks. Using a unique data set and field experiment performed by De Mel, McKenzie, and Woodruff (2008), it examines the heterogeneity in the treatment impact on microenterprise profits and first applies quantile regressions to illustrate the effects of capital shocks for different microenterprises. It also identifies the distributional characteristics of individual-specific coefficients.

Treatment effects of capital shock on microenterprises are nonlinear in different quantiles of real profits, suggesting firms with different capital levels have different profit growth rate. The effects of common parameters and treatment are identified in randomized coefficient panel data model. Results show that risk aversion of entrepreneur and the uncertainty of the projects have significant impacts on returns for firms in the lower quantile of profits in the sample.

Quantile regression shows significant heterogeneity patterns of entrepreneurs' characteristics on real profits. The non-convex curve for coefficients of number of paid workers shows that large firms pay higher marginal wage on hiring and heterogeneity in wages dominates the impact on profits and capital stocks. Male entrepreneurs have a relative advantage in operating and managing the firms, especially for large firms.

This paper provides two main explanations of the nonlinearity in the returns to capital shocks: the exact form of the production function (increasing returns to scale) and the heterogeneity in entrepreneur characteristics. It separates these two causes of non-convexity in production function by considering the intersection between treatment dummy of capital shocks and the predictors.

This paper comes up with a simple and systematic household model. It analyzes the heterogeneity effects and shed light on the empirical econometrics tools. The empirical results are explainable by the theoretical model. It offers insight to microfinance institutions on evaluation of microenterprise project and policy makers on development funding.

5.2 Further research

The broad role of microenterprises in developing countries is still under debate. One perspective argues that they may be highly productive firms held back by credit constraints or other frictions, while another view is that informal enterprises serve as a low-returns safety net for individuals excluded from the formal sector (Porta and Shleifer, 2008). In order to measure the market development level between credit and insurance markets, the future task is to seek a new Development Market Index (DMI) to setup a closer connection between theoretical model of microenterprises production and econometric nonlinear regression.

Contrary to the conclusion that high returns are closely associated with missing credit markets than missing insurance markets in DMW, this paper suggests both credit and insurance markets

imperfection affects the returns. One direction of further research is how to define the development market measure to weigh the insurance market and credit market.

The data employed in this study are quarterly survey data from April 2005 to April 2007. The length of the time series is not sufficient to include the seasonal lags (usually four lags for quarterly data) or by year (data only covers 2 years in total). Though there are nine waves available, the quantile regression only accounts for the first three waves as the treatment shocks happen at the first two waves. To quantitatively estimate the dynamics of the microenterprise development, new tools in quantiles for time-series-cross-section data are in need to control stationary covariates and (non-)linear time trend. This is another promising direction of further research.

From the comparison between density of profits and corresponding capital stock, we see the benefits from investment are not a monotone linear function of capital stock. There might be first an increasing in profits driven by capital increment while effects diminish as firm size enlarges. Further research goal includes comparing the short-run and long-run return to capital to evaluate the projects and make policy suggestions. It's also of interest to check the size effect of the firms and take into consideration the gender effect of management.

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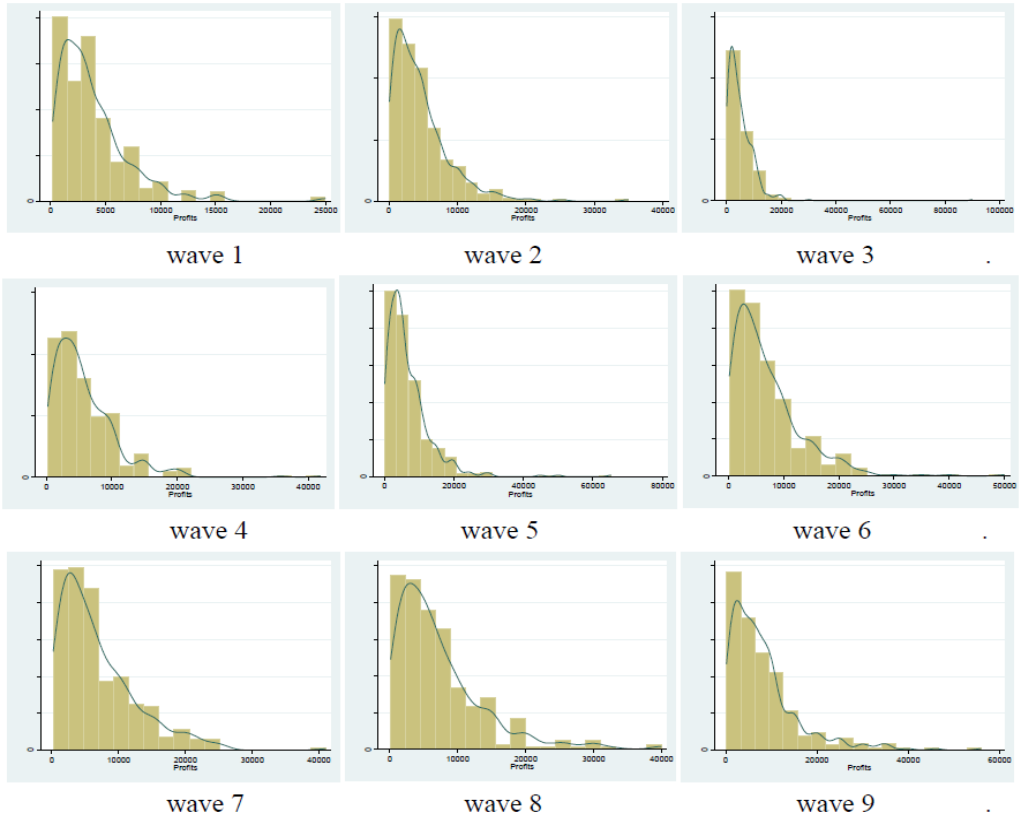
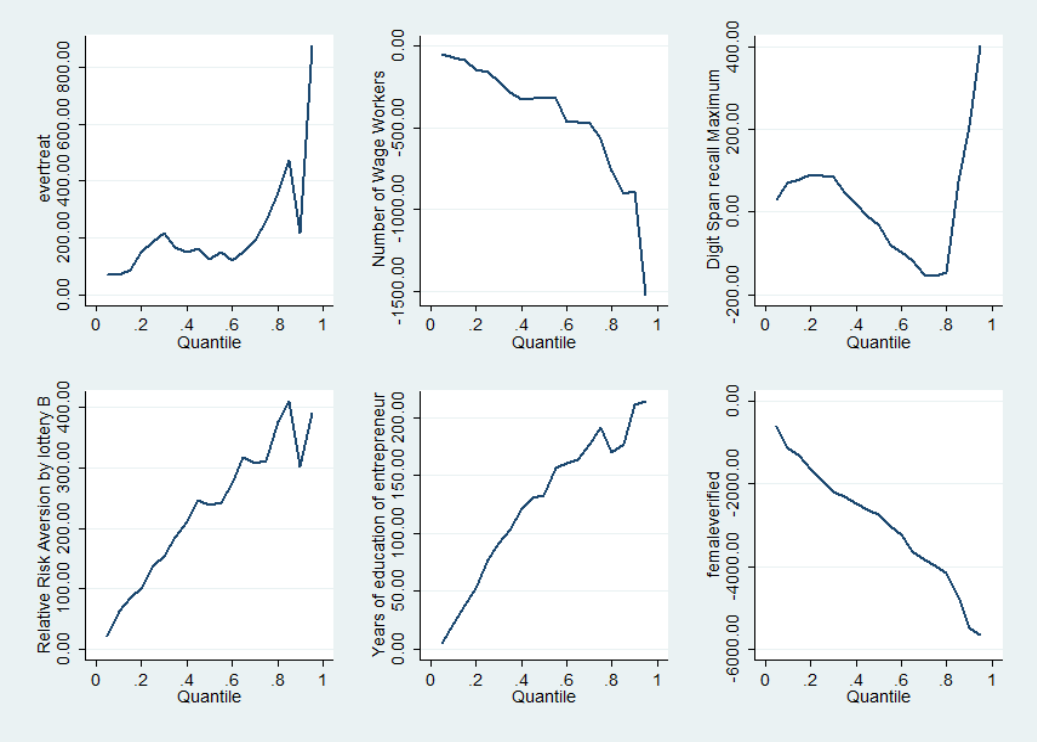
Figures and Tables

Figure 1: Profit Distribution (April, 2005-April, 2007, Quarterly Data)



Note: Profits are reported in Sri Lank Rupees.

Figure 2: Quantile regression



Note: Quantiles are in terms of Sri Lanka microenterprises' profits.

Figure 3: Plots of data in quantiles

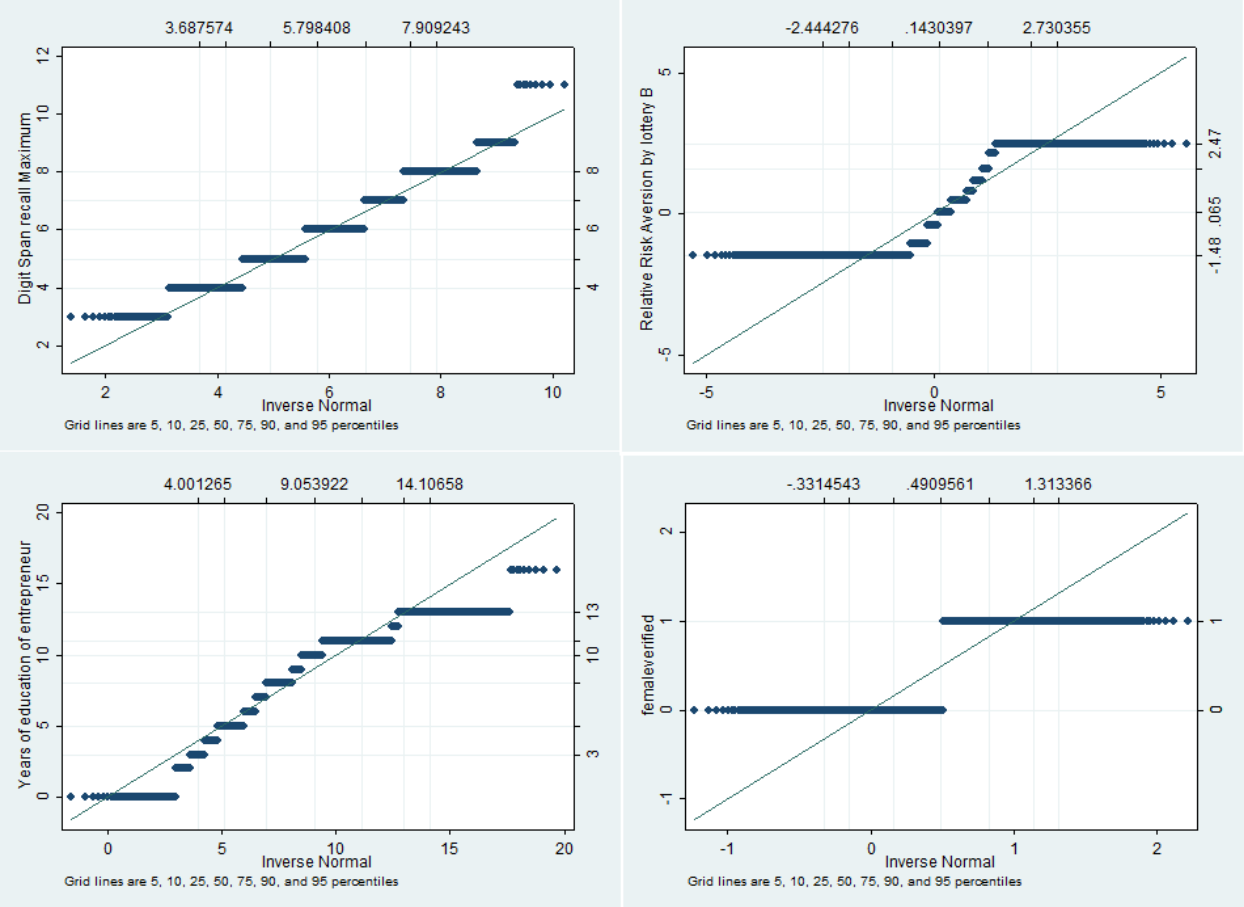


Figure 4: Plots of characteristics in terms of the distribution of real profits

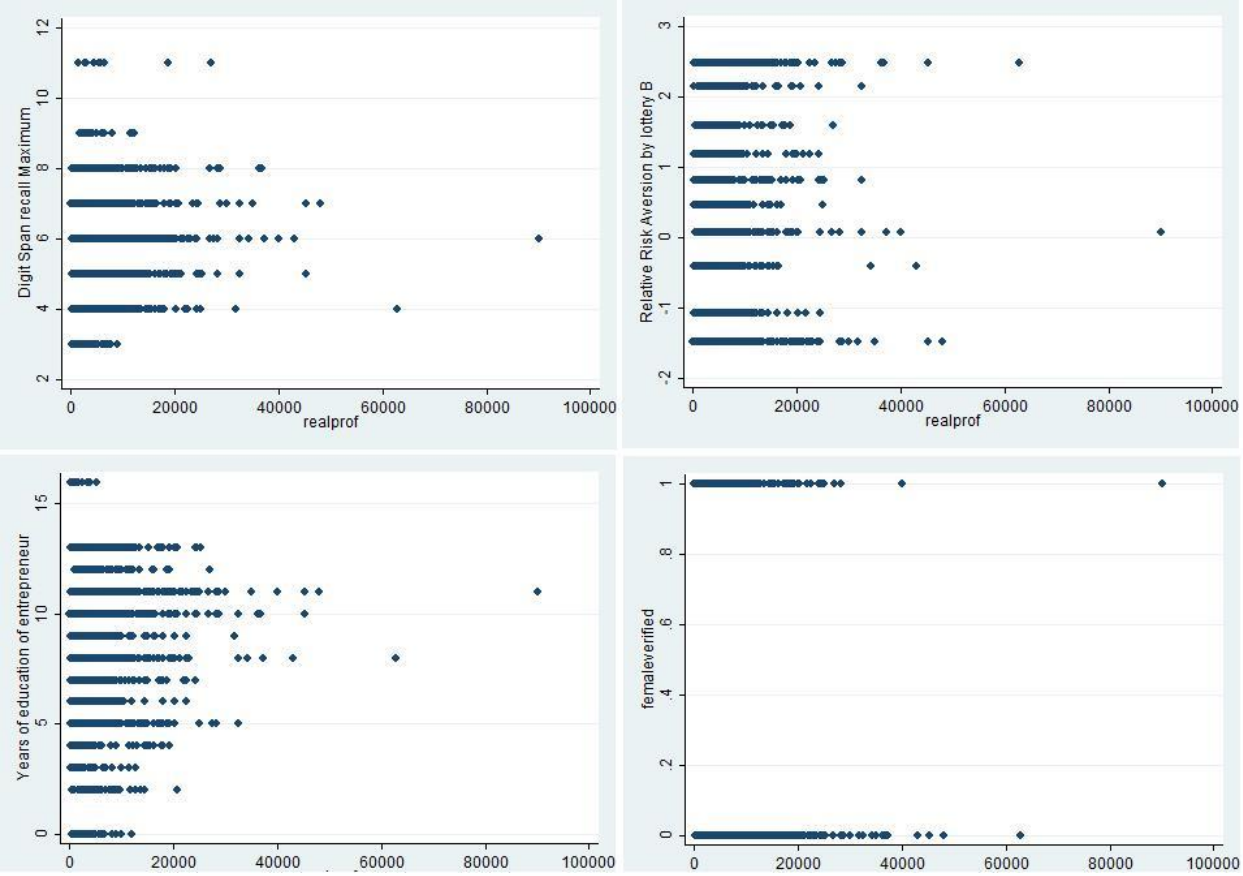


Figure 5: OLS predicted effects of digit span with 95% confidence interval

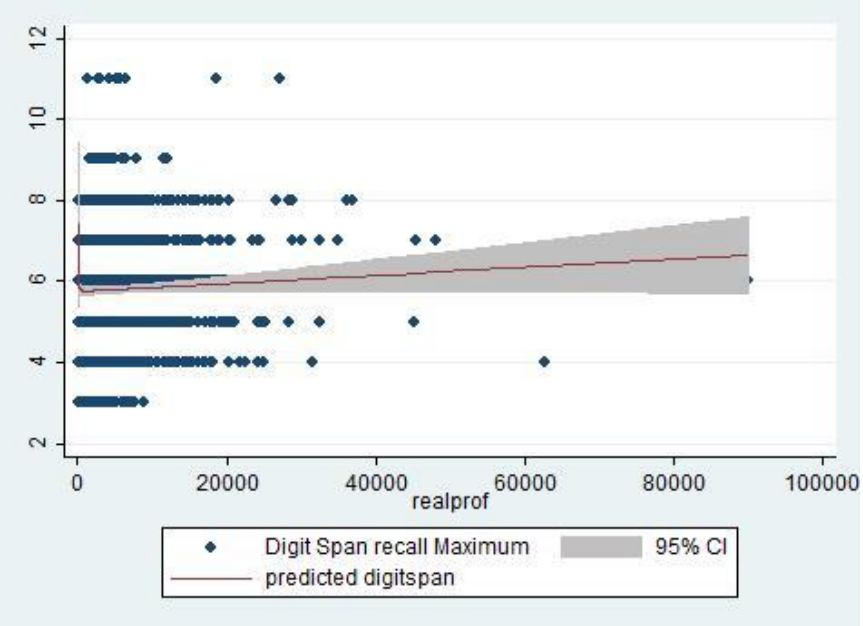


Figure 6: Quantile regressions with intersections

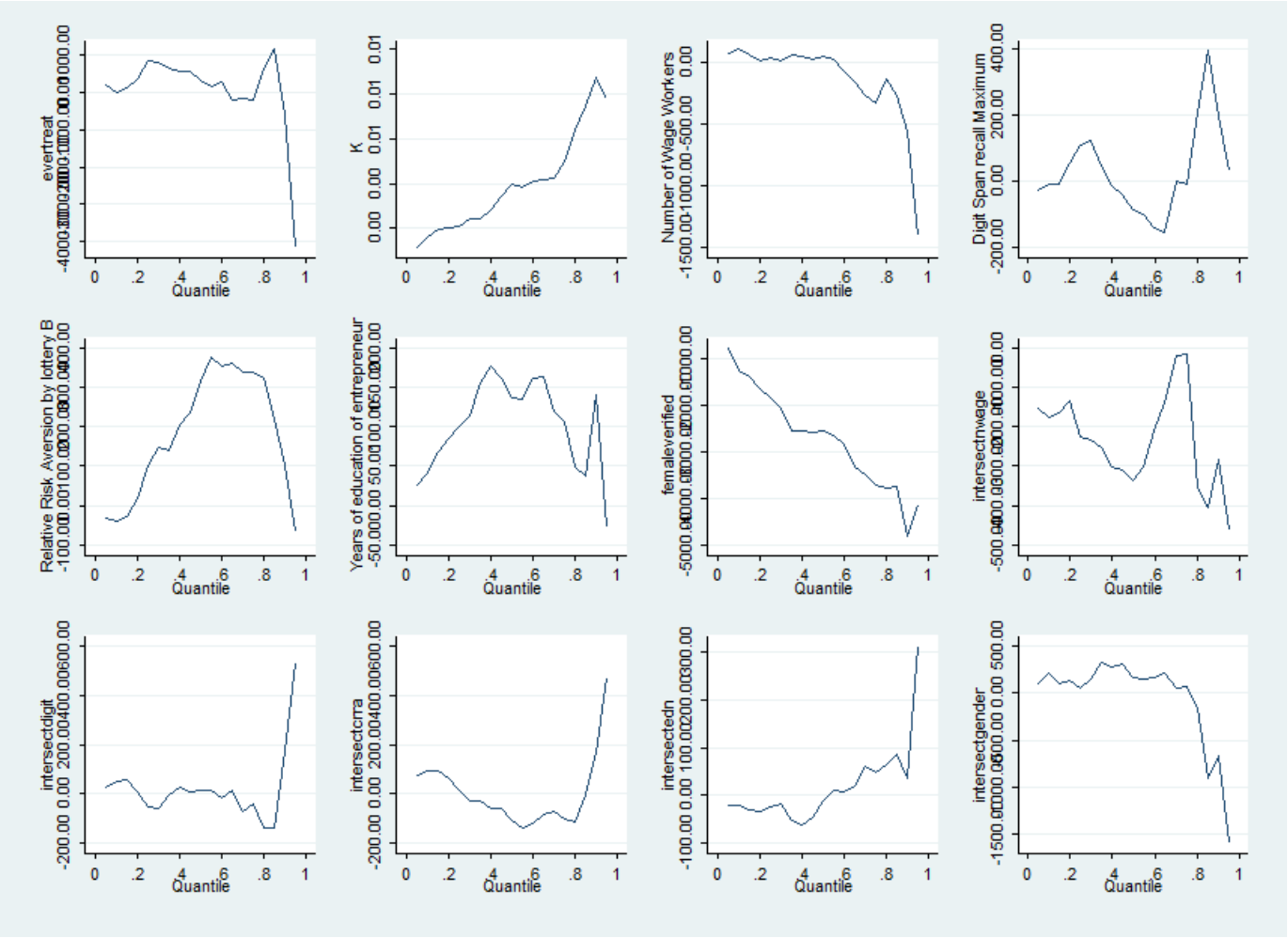


Table 1: Summary Statistics

	Baseline survey (Round 1)					Total data set	
Characteristic	# obs.	25%	50%	75%	mean	# obs.	median
Real profits	391	1500	3000	5000	3850	3308	4063
Total capital	408	36041	81500	16041	146805	3216	89787
# of workers	408	0	1	1	.699	3672	1
Age	408	32	41	50	41.833	3672	41
Digit span	377	5	6	7	5.598	3393	6
Lottery B CRRA	403	-1.48	.065	1.59	.143	3672	.065
Gender	387	0	0	1	0.491	3483	0
Education	408	8	10	11	9.053	3672	10

Note: All data based on baseline survey. Real profits and total capital are in Sri Lankan rupees. The sample is randomly assigned to the control and treatment groups. Entrepreneur ability is the number of digit span remembered in the test. Risk aversion is the CRRA calculated from a lottery B exercise.

Table 2: Capital shocks effects on microenterprises' real profits

	Quantile					
	0.10	0.25	0.50	0.75	0.90	OLS
Treatment	70.72	187.57***	125.12	259.46**	217.85	230.73***
	(52.04)	(91.12)	(109.59)	(195.76)	(286.40)	(116.82)
# of workers	-69.65**	-159.39***	-317.58***	-567.71***	-889.10***	-564.59***
	(41.77)	(34.20)	(91.60)	(114.12)	(313.24)	(114.75)
Ability	69.80***	86.13***	-30.61	-153.99***	209.40	64.06
	(25.06)	(37.28)	(59.89)	(82.49)	(193.18)	(76.88)
Risk aversion	62.53***	138.31***	238.24***	310.84***	301.14***	215.73***
	(23.61)	(27.41)	(69.42)	(71.87)	(185.81)	(61.03)
Education	22.65	77.12***	133.29***	191.81***	211.56***	140.94***
	(14.99)	(15.79)	(27.48)	(32.89)	(79.87)	(32.61)
Gender	-1130.7***	-1953.6***	-2747.1***	-3993.1***	-5496.1***	-3014.9***
	(74.37)	(107.03)	(186.83)	(247.66)	(563.89)	(200.15)
Constant	1160.7***	2088.9***	4736.6***	8508.8***	11595.8***	5671.1***
	(208.29)	(208.48)	(431.69)	(747.75)	(1332.13)	(502.75)

Note: Capital and profits are measured in Sri Lankan rupees, deflated by the Sri Lankan CPI to reflect March 2005 price levels. Profits are measured monthly. All regressions include enterprise and wave fixed effects. Standard errors, clustered at the enterprise level, are shown in parentheses. Sample is trimmed for top 0.5% of changes in profits. * 90% confidence interval, ** 95% confidence interval, *** 99% confidence interval.

Table 3: Quantile Regression

Real Profit	Quantile				
	0.1	0.25	0.5	0.75	0.9
Treatment	70.7234*	187.5738***	125.1211*	259.4602*	217.8542
Bootstrap S. E.	52.0415	91.1204	109.5926	195.7647	286.4098
Risk aversion	62.5314***	138.3196***	238.2475***	310.8404***	301.14***
Bootstrap S. E.	23.6137	27.4102	69.4261	71.8958	185.8184
Pseudo R2	0.0457	0.0666	0.0824	0.0862	0.0889

Note: The total number of observations is 3027 and the standard errors are obtained from bootstrapping to fit the base model. * 90% confidence interval, ** 95% confidence interval, *** 99% confidence interval.