Capital returns, productivity and accumulation in micro and small enterprises: Evidence from Peruvian panel data

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Abstract

This paper investigates the returns to capital, productivity and capital accumulation using a unique panel dataset for Peruvian micro and small enterprises (MSEs). Our analysis integrates recent empirical approaches that have focused on the returns to capital in MSEs into a dynamic perspective. To this end, we first analyze patterns of capital returns to test whether we can confirm recent findings of high returns at low levels of capital stock. This is indeed the case for small-scale activities with low capital stocks in Peru, thus contradicting perceptions of these activities constituting a stagnant subsistence segment of the urban economy. While some sectors appear to be less dynamic, quite a number of small-scale activities exhibit dynamics that resemble those found in more advanced economies. This is shown by our dynamic analyses of capital accumulation in MSEs. The analysis of firm growth suggests that small-scale entrepreneurs operate under severe constraints on credit markets and in risky business environments, which in turn explain why returns to capital are so high at low levels of capital.

Keywords: Informal sector, credit constraints, risk, firm growth, Peru.

JEL codes: D13, D61, O12.

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This is work in progress. Its dissemination should encourage the exchange of ideas about issues related to entrepreneurship and informality. The findings, interpretations and conclusions expressed in this paper are entirely those of the authors. They do not necessarily represent the views of the World Bank, the donors supporting the Trust Fund or those of the institutions that are part of the research consortium.

Table of Contents

1. Introduction

Income from micro- and small enterprises (MSEs) constitutes the main livelihood of the growing number of poor urban dwellers in developing countries. It is widely assumed that some of these MSEs may not be able to realize their full earnings potential, as their owners face important economic constraints, for example entry barriers and limited access to credit, thus providing a rationale for policy interventions, such as micro-credit programs. Recent empirical research seems to confirm that this is indeed the case. Several studies have found very high marginal returns to capital in MSEs in poor countries – typically well above market interest rates and in some studies highest at very low levels of capital stock (De Mel, McKenzie, Woodruff, 2008; Grimm, Krüger and Lay, 2011; Kremer, Lee, and Robinson, 2010; McKenzie and Woodruff, 2006; McKenzie and Woodruff, 2008; Udry and Anagol, 2006). These high returns in small-scale activities, such as petty trade, are typically found on average, and not for selected groups of entrepreneurs with high potential. This line of empirical research hence strongly contradicts the perception of small-scale activities in poor countries mainly representing an urban subsistence segment with little earnings potential and no growth prospects.

Rather, an important part of these MSEs appears to be severely constrained and high returns hint at credit constraints as one major obstacle to firm growth and success. Empirical work that explicitly addresses the importance of credit constraints (Banerjee and Duflo, 2004; De Mel, McKenzie, Woodruff, 2008; McKenzie and Woodruff, 2008; Schündeln, 2006) confirms this notion. Yet, credit constraints may only partly explain the observed high returns to capital. The persistence of small-scale activities in many poor countries is difficult to reconcile with very high returns to capital, as successful entrepreneurs should be able and willing to re-invest a part of their high returns into their MSE, thereby overcoming credit constraints and accumulating capital. Risk, however, may be the reason why this is not the case, as optimal capital stocks may be much lower than in less risky environments. The empirical literature generally has difficulties in the operationalization of risk and risk attitudes, which may explain why so far empirical research has little to say on the role of risk for MSE performance. An exception is De Mel et al. (2008) who are, however, not able to identify any effect of risk on returns to capital. There is, however, indirect evidence of the role of risk, in particular the high rates of churning among informal MSEs in developing countries (Mead and Liedholm, 1998). In general, the dynamics of MSEs, in particular expansion and contraction, have received little empirical attention, with the exception of the set of studies summarized by Mead and Liedholm (1998) and the more recent work on a panel dataset of Mexican MSEs (Fajnzilber, Maloney and Rojas, 2006). Examining these dynamics, however, will help understand the nature and importance of the constraints MSE face and the effects on their performance.

Our study hence aims at providing new empirical insights on the dynamics of small-scale activities in developing countries and the factors that explain these dynamics using a unique panel dataset for Peruvian MSEs. Our analysis integrates recent empirical approaches that have focused on the returns to capital in MSEs into a dynamic perspective. To this end, we first analyze the pattern of capital returns to test whether we can confirm previous findings of high returns at low levels of capital stock. More specifically, we estimate production functions for MSEs, from which we derive marginal returns to capital and compute total factor productivities. This static analysis will be complemented by an analysis of the determinants of capital accumulation in MSEs that we link to the former analysis of returns and productivity.

The remainder of the paper is organized as follows. In Section 2, we present some theoretical considerations and review the corresponding previous empirical evidence. In Section 3 we briefly describe the dataset and the basic characteristics of Peruvian entrepreneurs and their enterprises. Subsequently, Section 4 discusses in detail the results of our empirical analysis. The final section 5 summarizes our main findings and concludes with a focus on policy implications.

2. Small-scale activities in developing countries: Theoretical considerations and previous evidence

Incomplete capital markets have long been stressed as a major economic constraint to entrepreneurial activity in developing countries (e.g. Tybout, 1983; Bigsten *et al.*, 2003). Information asymmetries and moral hazard that cause capital market failure are typically exacerbated in developing economies and more so for MSEs. Informal entrepreneurs with different capacity to provide collateral may therefore face different costs of capital, which in turn causes some entrepreneurs to produce with a sub-optimal level of capital stock. Alternatively, the capital-constrained entrepreneur may choose (or rather be forced) to invest in different technologies (Banerjee and Duflo, 2005). In the presence of capital constraints, capital does hence not flow to its most productive uses.

Risk is the second fundamental force that affects investment, capital stocks, and returns to capital of MSEs. Similar to capital constraints, risk drives a wedge between market interest rates and marginal returns, as risk-averse entrepreneurs demand a risk premium on their invested capital stock. What differs here between entrepreneurs, however, is not the capital cost that they face, but the shadow value that they attach to marginal risky profits. Compared to risk-neutral entrepreneurs, this shadow value will be lower for a given investment, and risk-averse individuals will hence invest less into risky entrepreneurial activities. MSE activities with low levels of capital stock are likely to be highly vulnerable to shocks. Accordingly, most MSE activities are short-lived[1] and entrepreneurs move in and out of business. Fafchamps (1999) notes that in such a risky environment without appropriate contract-enforcing formal institutions, true business risk is likely to be compounded by opportunistic and contractual risk. The argument is that high exposure to risk makes it easy to falsely claim inability to comply with contractual obligations towards a business counterpart. Entrepreneurs can use various strategies to deal with the risks associated with their business activities, including diversification and precautionary savings. If entrepreneurs are capital constrained, these strategies may lead them to invest even less into their enterprises.

[1] This also holds for the activities in our dataset, as we will show below.

These fundamental mechanisms determine the steady-state capital stock of MSEs. Yet, most enterprises will not be observed in a steady state, but in phase of adjustment, in particular in the presence of risk and other market imperfections. Investment has hence to be seen as a dynamic decision. In a dynamic setting, entrepreneurs can overcome credit market constraints by retaining earnings (Evans and Jovanovich, 1989; Cabral and Matá, 2003). This strategy should allow credit-constrained entrepreneurs to accumulate capital, particularly if marginal returns are high at low levels of capital. Capital stocks would then be increasing with enterprise age and capital accumulation would be faster the higher marginal returns. Risk also implies gradual adjustment to a steady-state. In risky environments, there is an option value of postponing a partially or totally irreversible investment when more information on investment profitability becomes available through time (Dixit and Pindyck, 1994). Partial irreversibility is likely to be of more relevance in the context of urban MSEs. The value of waiting could lead to a stepwise approximation to an optimal level of capital stock, as more information on the profitability (and the entrepreneur's ability) of a certain activity becomes available (Jovanovic, 1982).[2] Alternatively, such a stepwise approximation could simply result from reduced risk when an entrepreneur learns about his business risks and how to deal with them in the course of time.

There is now quite some evidence for very high returns to capital in small-scale activities in developing countries. Most of these studies hint at credit market constraints as a likely cause of these high returns, while there is less evidence on role of risk. In contrast, only few studies have examined capital accumulation in MSEs, which can certainly be attributed to the lack of panel data on these activities. Recent evidence on capital returns and the underlying causes comes from social experiments. De Mel et al. (2008), for instance, use data from a randomised experiment to estimate returns to capital of Sri Lankan microenterprises. In this experiment, the authors randomly provide cash or in-kind transfers to microenterprises. They use the random treatment as an instrument for changes in the capital stock and find marginal returns to capital in a range from 55 to 70 percent per year. Furthermore, by analysing the heterogeneity in treatment effects, they are able to show that the high marginal returns are likely to be caused by credit constraints rather than insurance market failure. Consistent with credit market constraints, de Mel et al. (2008) find treatment effects, i.e. marginal returns to capital, to be lower (higher) for wealthier (poorer) entrepreneurs. However, they cannot detect significant differences in marginal returns between risk-averse and less risk-averse entrepreneurs. Nor does risk have the expected positive effect: If anything, they can find a negative risk premium, i.e. marginal returns are lower for those who report higher profit variation. In a similar experiment in Mexico that provided cash and in-kind grants to small retailers, McKenzie and Woodruff (2008) also find very high returns of at least 20–33 percent a month – three to five times higher than market interest rates. Returns are highest among firms with capital stocks near $200 that report being financially constrained – up to 100 percent monthly marginal returns. At least for this selected group, there is hence a strong indication for credit market imperfections causing high returns at low levels of capital.

[2] Fafchamps (1999) shows this option value can be positive even without additional information if agents are credit-constrained, i.e. there is a value of using own resources for consumption smoothing.

This evidence is in line with earlier non-experimental findings by McKenzie and Woodruff (2006) using data from Mexico's National Survey of micro enterprises (ENAMIN). This study looks at the heterogeneity of returns to capital at different sizes of capital stock as well as entry barriers for entrepreneurs into different economic activities. Returns to investment turn out to be very high at low levels of capital (20 percent per month), but much lower at capital levels of 400 to 800 USD with about five percent (per month). In addition, McKenzie and Woodruff (2006) find start-up costs to vary considerably by sector, but these costs do not seem to constitute major entry barriers when compared to income levels of entrepreneurs. Yet, they do provide some evidence that supports the existence of capital market constraints, as asset-poor households are more likely to have MSEs with low levels of capital stock (and high marginal returns). Not surprisingly, asset-poor households are completely excluded from access to formal credit, which implies that they have to turn to moneylenders who charge extremely high borrowing rates. The authors also test whether MSEs acquire more capital as they learn about the profitability of investment by looking at the share of new entrants at different levels of capital. In contrast to expectation, they find younger firms to have higher capital stocks. McKenzie and Woodruff (2006) also analyze the role of risk by examining the variability of earnings at different levels of capital stock. Their results suggest that entrepreneurs with lower levels of capital do not face higher risks in terms of earnings variability (measured by the coefficient of variation in earnings).

While these fairly recent empirical studies focuses on returns to capital and their causes, there is a separate literature that examines the dynamics of MSEs (Mead and Liedholm, 1998; Faijnzilber et al., 2006). Mead and Liedholm (1998) summarize the findings of a research project on MSE dynamics, which draws (partly) on panel datasets of MSEs from a number of developing countries. The authors typically find high rates of churning among MSEs, with survival being positively associated with firm age, smaller initial size and past growth. The analysis of firm growth shows that MSEs that were smaller at start-up tend to grow more rapidly than their larger counterparts; younger firms also grow faster. These results are similar to those obtained by Faijnzilber et al. (2006) using (again) the Mexican ENAMIN data. They conclude that microenterprises in Mexico show dynamic patterns consistent with a number of standard results from the theoretical literature on firm dynamics. This general view is confirmed by a comparison between Mexican and United States' microenterprises that shows remarkable similarities of self-employment in these two countries. While these two studies do a good job in describing some dynamic features of MSEs in developing countries, they have little to say on the causes of differences in behaviour. Faijnzilber et al. (2006) do present some suggestive evidence in favour of credit constraints[3] causing some of the observed patterns. Yet, they concede that simultaneity renders a causal interpretation of their findings speculative.

One of the few studies that explicitly shows the impact of capital constraints on accumulation patterns of small (albeit not micro) enterprises is a case study of the knitted

[3] They regress employment growth on dummies for credit at start-up and dummies for subsequent credit (and a set of other controls). They find lower subsequent growth for firms with start-up credit – as these firms reach their optimal capital stocks more rapidly – and higher growth for those with subsequent access to credit – as these firms can more quickly adjust to their optimal levels.

garment industry in Tirupur in Southern India by Banerjee and Munshi (2004). The authors find large and systematic differences in both levels of capital stock and the capital intensity of production in firms owned by people from two different community groups. These differences are likely to be due to differences in access to capital between these two groups, as one of these groups, the Gounders, from a relatively wealthy agricultural community, were the first to move into the garment industry in Tirupur. Banerjee and Munshi (2004) argue that the incumbent Gounders start their businesses with much higher levels of capital stock than comparable outsiders because of their stronger ties to the local community and the associated better access to finance. Both groups accumulate capital over time, but the outsiders do so much faster to catch up with the Gounders after approximately 7 years. In addition, capital stocks do not significantly differ at this stage despite the fact that the Gounders are found to be less productive than their counterparts.

These theoretical considerations together with previous empirical approaches provide the conceptual framework for our empirical analyses. Below, we thus first examine the patterns of returns to capital and test whether we can also find high returns to capital at low levels of capital stock in Peruvian MSEs. Second, we analyze the determinants of capital accumulation. This analysis incorporates both variables from standard theories of firms' accumulation behavior, such as enterprise age, and proxies for capital constraints and risk. In addition, we link the analysis of accumulation to our estimates of production functions by considering the influence of firm-level total factor productivity on capital accumulation.

3. Data and MSE characteristics

Our analyses are based on data from the nationally representative Peruvian household survey (ENAHO) collected by the National Statistic and Informatics Institute (INEI) between 2002 and 2006.[4] The ENAHO comprises around 20000 households each year and it entails a panel sub-sample of about 5000 to 6000 households (again nationally representative) of which 55-80 percent of the interviewed households are re-visited in the following year (see Table 1). Around 18 percent of the visited households are not interviewed as the household refuses, is absent, the house is unoccupied or other reasons (miscellaneous category).[5]

Table 1: Panel survey

Year	Hh. visited	Hh. not interviewed	Hh. observed in previous period	Hh. interviewed	Panel MSEs
2002	6257	847	.	5410	2405
2003	4217	688	3068	3529	1749
2004	6490	1141	2787	5349	2894
2005	6778	1469	4146	5309	3076
2006	6593	1182	4496	5411	3306

[4] In 2002, the survey took place during the 4th quarter (Oct-Dec). Starting from May 2003, the survey is permanent (the whole sample is distributed monthly along the year).

[5] This leads to an unbalanced panel with 719, 1435, 1153, 1870 and 2096 households being observed in one, two, three, four and five years, respectively. The fact that this number is increasing reflects increased effort by INEI to create a larger panel dataset. Quite a number of panel households were not interviewed in consecutive years.

The survey provides detailed information on individual socio-demographic characteristics and employment. All individuals identified as independent workers or as employers (in principal or secondary employment) are interviewed in an Informal Sector Module that captures the characteristics of the entrepreneurs and their production unit. It also contains detailed information on input use, sales, value-added and the legal status of the firm as well as characteristics of employed workers. We can use this module and the household panel to construct an unbalanced panel dataset of MSEs with 4604, 1777, 769, 440 and 241 MSEs, which we observe in one, two, three, four and five years, respectively. In the subsequent descriptive analyses, we use the pooled cross-sections 2002-2006 with about 33000 observations. We restrict our analysis to individuals in urban areas i.e. in cities with at least 4000 inhabitants.

3.1 Employment in MSEs

MSEs account for the vast majority of employment in Peru as illustrated in Table 1. About a third of the Peruvian workforce is self-employed. Another almost 30 percent work as paid worker or unpaid family aid in informal firms defined as firms without written accounts. With very few exceptions, these firms are MSEs of very small size. Compared to men, more women tend to be either self-employed or work as unpaid family members. In wage-employment, however, the share of formal jobs is higher than for men.

Table 2: Structure of employment in Peru (in percent)

	Total	Male	Female
Wage employment	46.24	51.85	39.62
of which			
Formal sector	58.03	55.55	63.73
Informal sector	41.94	44.41	36.26
Self-employment or Employer	33.83	32.35	35.57
Unpaid family work	8.18	5.86	10.92
Unemployed	12.03	14.21	14.21
Observations	100	54.09	45.91

Source: Authors' calculation based on the pooled cross-sections from ENAHO, 2002-2006.

3.2 MSE and owners' characteristics

Table 3 reports some basic characteristics of Peruvian MSEs and their owners by capital quartiles. MSEs are typically very small with a mean firm size of 1.6 including the owner. Almost one third of the firms operates with the help of unpaid family members and only 11 percent employ paid staff. Less than 0.1 percent of the surveyed firms report to engage at least 10 workers (including unpaid family members). Incomes from MSEs are fairly low, with average monthly value-added[6] of about 145 US Dollar (USD) and a median of about 90 USD. The average capital stock amounts to 591 USD, but this high average results from only few

[6] We measure value-added as the value of monthly sales plus self-consumption minus non-labor and non-capital expenses, including expenses for intermediate inputs and electricity.

enterprises with very high capital stocks. Hence, median capital stock is much lower with only 49 USD. Comparing firms with different levels of capital stocks, Table 3 shows that the first quartile basically works without capital and without staff apart from the owner resulting in very low value added of not even 100 USD. At higher levels of capital, firms are not much larger and the average firm in the highest capital quartile only employs one additional person. Value added is about 20 to 30 percent higher when we compare the first (second) to the second (third) quartile and much higher in the forth quartile (50 percent higher than in the third). Much more pronounced, however, are the differences in capital stocks. The median capital stock of is only 18 USD in the second quartile and jumps to 119 and 2259 USD in the third and fourth quartile, respectively. This implies that raw capital profitability, i.e. valued added/capital, is much lower for firms with higher levels of capital stocks. Average enterprise age of about 8 years is higher than one might expect. Yet, the median age of 4 years indicates that a large part of Peruvian MSEs represent transitory forms of employment.

Table 3: Basic descriptive statistics of MSEs by quartiles of capital stock

	all	1 quartile	2 quartile	3 quartile	4 quartile
MSE characteristics					
Number of staff (including owner)	1.6	1.2	1.6	1.7	2
Self-employed (%)	65.45	84.4	64.26	61.02	52.06
Paid staff (%)	20.11%	5.35%	12.79%	17.60%	44.72%
Unpaid staff (%)	39.77%	17.02%	42.50%	48.33%	51.27%
Monthly value-added in USD (mean)	145	91	113	140	234
Monthly value-added in USD (median)	89	51	78	96	152
Capital stock in USD (mean)	591	1	21	142	2244
Capital stock in USD (median)	49	0	18	119	1159
Enterprise age (mean)	7.8	6.5	8.5	7.8	8.3
Enterprise age (median)	4	3	5	4	5
Owners' characteristics					
Gender: Male (%)	49.92	39.54	45.18	51.27	63.71
Owners' age	41	40	43	41	42
Owners' education	10	9	9	10	11
Observation	33269	8317	8317	8317	8317

Source: Authors' calculation based on the pooled cross-sections from ENAHO, 2002-2006.
Notes: Monetary values are deflated using the INEI Consumer Price Index into Dec. 2001 Nuevo Sols and converted into US-$ using the Dec. 2001 nominal exchange rate.

Table 3 also reports some basic characteristics of the MSE owner who is, on average, 41 years old and has been to school for 10 years. In half of the MSEs, the owner is female. While the average age does not vary much over capital quartiles, education and especially gender do. MSEs operated by women or by individuals with less schooling have lower capital stocks.

3.3 Composition of activities

Most MSEs can be found in petty trading (41 percent) followed by transport (14 percent), other services (14 percent), other manufacturing & food (11 percent) and hotels and restaurants (11 percent) (see Table 4). Gender-specific preferences in the sector choice become obvious. While MSEs in the industries hotels and restaurants and petty trading are mostly (88 and 68 percent, respectively) owned by women, firms operation in the primary, construction or transport sector are nearly always headed by a man (91, 100 and 99 percent, respectively). Comparing the male and female dominated sectors, the monthly value-added but also the capital stock seem to be higher in male dominated sectors (with the small primary sector as an exception).

3.4 Dynamics of MSEs

Data presented in Table 4 show that MSEs are being established and closed at a substantial rate. Depending on the sector, new starts during the year sum up to 28 – 50 percent of all existing firms. Similarly, of all observed firms between 21 and 46 percent close every year. Entry (as well as exit) rates seem to be higher in sectors that require less capital. In the capital intensive sectors wholesale/retail shops and transport the entry and exit rates are the lowest but with over 20 percent still substantial. Interestingly, new firms are remarkably similar to established firms in terms of monthly value-added and capital stock. While MSEs in most sectors accumulate capital, firms in the primary sector seem to reduce their capital stock.

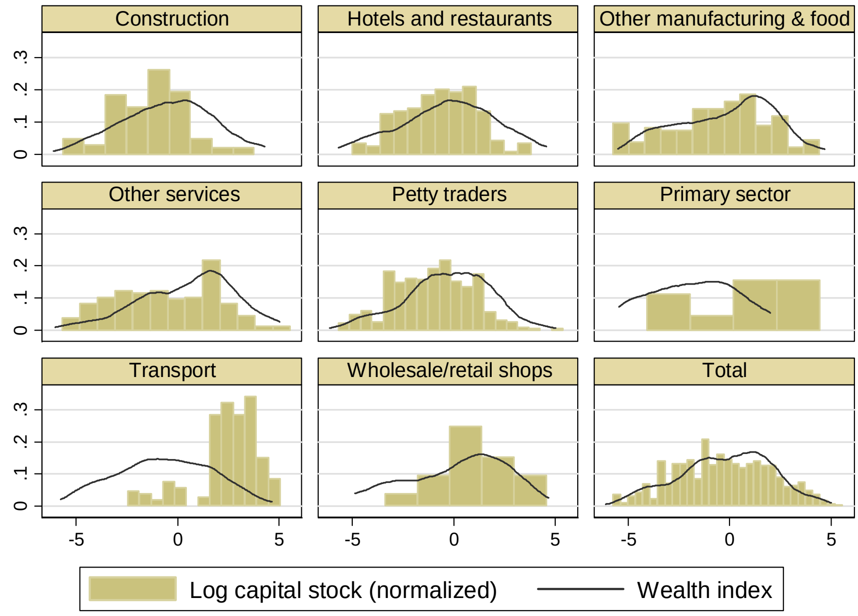
Table 4: Basic descriptive statistics of MSEs by sector

	Prim. Sector	Manuf.& food	Constr.	W./R. shops	Petty trading	Hotels& restaur.	Transp.	Other serv.
Gender: Male (%)	91.34	55.65	99.93	84.88	31.81	12.24	98.72	52.96
Owners' education	9	10	10	11	9	9	11	11
Self-employed (%)	69.82	58.95	56.65	47.02	61.20	41.86	91.16	83.28
value-added (med.)	146	87	146	184	69	74	135	66
– new firm	158	63	144	144	63	51	130	50
Capital stock (med.)	66	110	28	166	21	54	1456	12
– new firm	294	60	22	248	9	39	902	5
Entry rate (%)	44.00	35.49	44.58	28.23	30.80	34.24	34.36	50.26
Exit rate (%)	31.11	31.76	41.89	20.80	28.92	34.69	28.43	45.56
Observation (%)	1.15	10.85	4.61	3.08	41.09	11.42	14.04	13.77

Source: Authors' calculation based on the pooled cross-sections from ENAHO, 2002-2006.
Note: Entry and exit rates are based on the panel sub-sample from ENAHO.

To address the concern about possible entry barriers into certain activities, Figure 1 examines the distribution of initial investment and household wealth. The wealth index is derived from principal component analysis based on household assets including only non-business assets, such as color televisions or the condition of the house, for example the state of the walls and the quality of sanitary facilities. The lower right figure shows the distribution of initial investment and wealth for all sectors. The histogram represents the logarithm of capital stock for new entrant firms normalized by the mean of all firms. It indicates that the capital stock of new entrant firms is lower than the mean. The density line is the wealth index normalized to zero for all households. Negative values seem to be overrepresented, consequently households of individuals that establish a business are poorer than the average. The most capital intensive sectors are wholesale/retail shops and transport. Indeed, the figures show that entrepreneurs that start in the sector wholesale/retail shops are much wealthier than the average while this cannot be confirmed for the transport sector. The construction and petty trading sectors require the lowest level of start-up capital, and entrepreneurs have an average wealth level. Summing up, a very slight correlation between the distribution of wealth and of initial investment can be found, which is more pronounced in the wholesale/retail shops sector. There is no evidence that entry barriers into self-employment are important.

Figure 1: Distribution of the wealth index and initial investment by sector



Source: Authors' calculation based on the pooled cross-sections from ENAHO, 2002-2006.
Note: The histogram is the logarithm of capital stock for new entrant firms normalized by the mean. The density line is the wealth index normalized to zero for all households.

4. Returns to capital and MSE dynamics

Our conceptual framework for the analysis of returns to capital and MSE dynamics blends several approaches that have been proposed in the literature. More specifically, we estimate a production function, the results of which then enter the analysis of capital accumulation of MSEs as well as the patterns of entry and exit.

We depart from a production function

$$Y_{it} = F(K_{it}, L_{it}, \Omega_{it}) \tag{1}$$

where Y_{it} is value-added of MSE i in period t, K_{it} and L_{it} are inputs of capital and labor, and Ω_{it} is the efficiency level or total factor productivity (TFP). In addition, capital stock K_{it} follows a standard accumulation function. We hence assume firms to exhibit have not yet reached their optimal capital stocks K_i^* because of credit market imperfection and risk, as described above.

$$K_{it+1} = (1-d)K_{it} + I_{it} \tag{2}$$

where d denotes the depreciation rate. We further assume that investment I_{it} is determined by the following reduced form equation.

$$I_{it} = I(K_{it}, \Omega_{it}, W_{it}, R_{it}). \quad (3)$$

The firm's decision to invest in additional capital depends primarily on a firm's capacity to retain earnings. This capacity is, in turn, determined by K_{it} (the initial capital stock in the period) and total factor productivity Ω_{it}. Firms with high productivity will then be able to accumulate faster. As marginal returns will (under neoclassical assumptions on the production technology) be higher at lower levels of capital, retained earnings and hence investment will also be higher. Initial capital stock will hence negatively affect capital accumulation. In addition, credit constraints proxied by the wealth W_{it} of the entrepreneur directly affect the ability to accumulate capital (as, for example, in Cabral and Mata, 2003). Moreover, the firm's exposure to risk R_{it} enters the investment function. The effect of risk will be ambiguous, as it influences accumulation through various channels. First, the option value of postponing investment is higher for riskier activities and accumulation hence slower. Second, risk premia can be used for re-investment and thus lead to faster accumulation of credit constrained firms in risky activities. However, this effect should be heterogeneous across firms, as more risk is associated with both higher expected profits and more variation. Hence, while firms that are able to realize high profits tend to accumulate faster, less successful ones may even incur losses and decumulate capital.

In the subsequent analyses we restrict our sample to firms from the panel-subsample in urban areas i.e. in cities with at least 4000 inhabitants. Furthermore, we exclude MSEs with non-positive values of value-added or capital stock. This leaves us with a sample of 4700 observations.

4.1 Capital returns

For estimation purposes we assume a log-linear transformation of a Cobb-Douglas production function

$$y_{it} = \alpha + \beta l_{it} + \gamma k_{it} + u_{it} \quad (4)$$

$$u_{it} = \omega_{it} + \varepsilon_{it} \quad (5)$$

with lower case letters referring to log values of labor and capital. u_{it} is not observed and is assumed to have two components: ε_{it}, an i.i.d. error term and ω_{it} = ($\ln(\Omega_{it})$)-). ω_{it} is known to the firm but unobservable to the researcher, and may be decomposed in a time-invariant and a shock part. We now estimate equation (4) separately by sector via simple OLS on the pooled ENAHO panel sub-sample. Moreover we split the sample in MSEs with a low (less than USD 100) and high (at least USD 100) capital stock. In all regressions, we drop influential outliers from our sample (and sub-samples) that we identify by the DFITS-statistic. As suggested by Belsley, Kuh, and Welsch (1980), we use a cutoff-value $|DFITS|_{ihj} > 2\sqrt{k/N}$ with k, the degrees of freedom (plus 1) and N, the number of observations.

Table 6 presents the production function estimates obtained from OLS at different levels of capital. Moreover, the implied marginal returns to capital are shown. With an average of 33 % monthly, returns to capital are very high at low levels of capital stock, but also very heterogeneous. While in the construction sector and the most capital intensive sectors wholesale/retail shops and transport the capital coefficient is not significant, it ranges between 18-81 % in the other sectors which account for 85 % of all observation at low levels of capital stock. Although the returns are rapidly decreasing, the associated income gains are high. If an entrepreneur within the low-capital group with mean capital (about 33 USD) and value-added (about 153 USD monthly) increased her capital stock by 10 USD her monthly value-added would rise by 3 USD, an increase – and permanent income gain – of about 2 percent. Doubling the capital stock from 33 to 65 USD would lead to a monthly income increase of about 8 USD or 5 percent.

Table 6: OLS estimator of the production function for Peruvian industries

		Log labor		Log capital				
Sector	Capital stock	Coefficient	S.E.	Coefficient	S.E.	R2	N	MRK
All sectors	All	0.696***	(0.020)	0.117***	(0.009)	0.429	4526	3.83%
	< 100USD	0.671***	(0.028)	0.069***	(0.018)	0.334	2242	32.73%
	>= 100USD	0.706***	(0.026)	0.203***	(0.019)	0.422	2269	4.37%
Other manufacturing & food	All	0.792***	(0.034)	0.173***	(0.020)	0.652	549	5.06%
	< 100USD	0.809***	(0.062)	0.183***	(0.051)	0.468	202	58.10%
	>= 100USD	0.781***	(0.046)	0.169***	(0.037)	0.623	352	4.11%
Construction	All	0.657***	(0.048)	0.091***	(0.022)	0.501	247	16.96%
	< 100USD	0.654***	(0.056)	0.013	(0.032)	0.436	194	10.05%
	>= 100USD	0.646***	(0.075)	0.252***	(0.073)	0.698	50	20.04%
Wholesale/retail shops	All	0.668***	(0.067)	0.086***	(0.028)	0.527	172	3.80%
	< 100USD	0.914***	(0.087)	-0.046	(0.065)	0.619	69	-33.16%
	>= 100USD	0.570***	(0.075)	0.146**	(0.060)	0.450	104	4.66%
Petty traders	All	0.644***	(0.036)	0.069***	(0.013)	0.237	1772	6.11%
	< 100USD	0.618***	(0.039)	0.039*	(0.020)	0.217	1146	17.97%
	>= 100USD	0.652***	(0.066)	0.225***	(0.046)	0.208	633	9.13%
Hotels and restaurants	All	0.889***	(0.048)	0.094***	(0.023)	0.553	616	10.23%
	< 100USD	0.779***	(0.050)	0.098***	(0.031)	0.519	337	42.04%
	>= 100USD	0.960***	(0.070)	0.130*	(0.069)	0.494	281	9.65%
Transport	All	0.550***	(0.044)	0.186***	(0.016)	0.425	708	1.82%
	< 100USD	0.454***	(0.109)	-0.060	(0.045)	0.237	82	-13.59%
	>= 100USD	0.566***	(0.047)	0.282***	(0.025)	0.392	627	2.63%
Other services	All	0.697***	(0.047)	0.192***	(0.023)	0.612	349	6.39%
	< 100USD	0.721***	(0.066)	0.203***	(0.048)	0.567	154	80.96%
	>= 100USD	0.710***	(0.063)	0.237***	(0.054)	0.459	192	6.36%

Source: Authors' calculation based on the ENAHO panel-subsample.
Notes: OLS standard errors (S.E.) are clustered by MSE; * p<0.10, ** p<0.05, *** p<0.01; Sector-year interaction dummies (or year dummies when estimated separately by sector) are included; MRK = marginal returns to capital are obtained from (2) as the product of γ and average *(Y/K)*.

Several biases may affect a simple OLS estimation of equation (4). A central problem we face is the classical omitted variable bias. Omitted TFP may not only influence value-added directly, but simultaneously determine input factor use. Profit-maximizing MSEs observe at least a part of their current productivity level and will increase the use of inputs as a result of positive productivity shocks. If we now assume that labor inputs can immediately adjust to productivity shocks, the labor coefficient will be upward-biased. If we further assume that capital is quasi-fixed and responds to changes in productivity only with an adjustment lag (see equations (2) and (3)) the direction of the bias of the capital coefficient depends on the correlation of the two inputs. Often a negative bias is expected. If labor and capital are positively correlated, but labor is more strongly correlated with the productivity term than capital, the capital coefficient will be underestimated.

Multiple ways to address these simultaneity problems have been proposed, including a fixed effects (FE) estimator, semiparametric proxy estimators and GMM system estimation. While the latter is not feasible with our dataset due to its limited time dimension, we briefly discuss the FE-estimator and a semiparametric proxy estimator proposed by Levinsohn and Petrin (2003) (henceforth LP). The FE uses only the variation within firms over time and is unbiased under the assumption of the unobserved firm-specific productivity being time-invariant. As the within-variation tends to be much lower than the cross-sectional variation, FE-coefficients are weakly identified and consequently biased towards zero. The semiparametric LP estimator uses intermediate/electricity inputs as a proxy for productivity shocks. Unfortunately about 15 % (66 %) of all MSEs in our sample do not use intermediate (electricity) inputs and would be excluded from the analysis. Both methods require a data richness which does not allow us to estimate the production function separately by sector, which is why we have opted for applying both methods only as a robustness check.

Table 7: Robustness: LP and FE estimator of the production function.

		Log labor		Log capital		
Method	Capital stock	Coefficient	S.E.	Coefficient	S.E.	N
LP	All	0.429***	(0.022)	0.102***	(0.015)	3942
	< 100USD	0.376***	(0.031)	0.063**	(0.032)	1873
	>= 100USD	0.484***	(0.030)	0.153***	(0.028)	2055
FE	All	0.416***	(0.022)	0.049***	(0.010)	4526
	< 100USD	0.400***	(0.033)	0.004	(0.019)	2261
	>= 100USD	0.379***	(0.034)	0.071***	(0.022)	2252

Source: Authors' calculation based on the ENAHO panel-subsample.

Notes: LP standard errors (S.E.) are bootstrapped with 500 repl.; * p<0.10, ** p<0.05, *** p<0.01.

Table 7 presents the LP and FE estimates. The LP coefficients on capital are very similar to the OLS coefficients for low levels of capital and all firms. At high levels of capital stock the LP coefficient is lower than the OLS estimate, but the difference is not significant at the 5 percent level. In contrast, the LP labor coefficients are significantly lower for all levels of capital employed. In terms of biases, we think that there is little reason to assume that our OLS estimates on the capital coefficients are biased, and that consequently the returns to capital stated in Table 6 are reliable. The OLS estimates on the labor coefficients seem to be biased upwards. The FE coefficients on labor and capital are both lower than the OLS and LP estimates, with at least partly reflects the bias towards zero due to the weakly identification.

While the FE and the LP estimator address concerns about omitted variables and simultaneity, additional errors in the production function estimates may arise from systematic firm entry and exit. If MSEs with a high capital stock are more likely to tolerate productivity shocks and remain in business the capital coefficient would be downward biased. This bias should be less pronounced in our estimates, as we use an unbalanced panel. In addition, an analysis of entry and exit (not reported) suggests that these biases are of no (or only minor) importance.

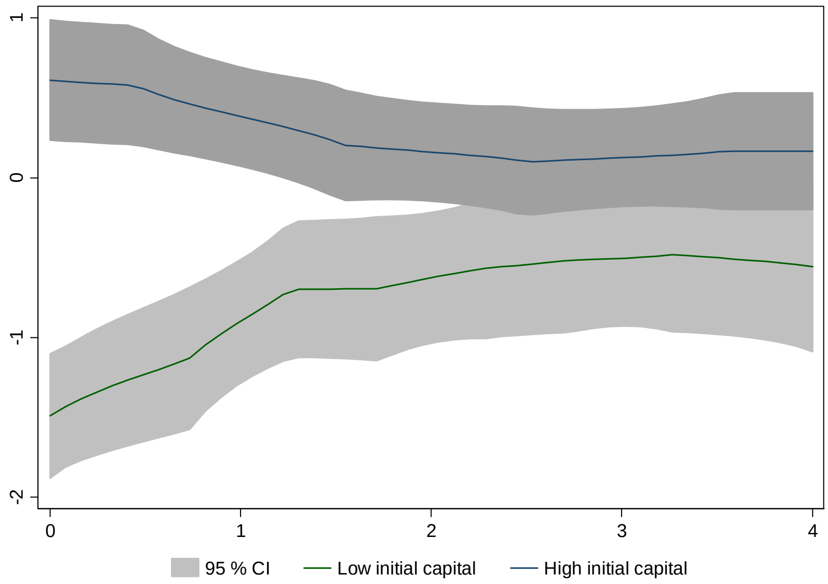
Measurement error of both profits and capital should tend to bias the estimated coefficients towards zero, so this source of bias does not give rise to major concerns in light of the significant strong effects. It is difficult to judge whether and how measurement error changes with higher or lower levels of profits and capital stock. We think there is little reason to assume that measurement error is less pronounced at lower levels of capital stocks, which would then partly explain higher returns at lower levels of capital.

4.2 Capital accumulation

The above analysis confirms earlier findings of high returns to capital at low levels of capital stock. In this section, we explore the determinants of capital accumulation. The above conceptual framework assumes that firms typically do not start with steady-state levels of capital. Figure 2 nicely illustrates that this is indeed the case. It shows the relationship between capital stock and enterprise age separately for two groups. More precisely, we follow Banerjee and Munshi (2004) by regressing the logarithm of capital on a full set of year and sector dummies and plotting the residual of this regression against enterprise age using local polynomial smoothing based on an epanechnikov kernel. The residual reflects the capital stock after controlling for the stated variables. Figure 2 is based on a sample reduced to young firms observed in four periods with a maximum age of three years old when first observed. The upper graph shows the capital stock of MSEs that can be found in the fourth quartile of initial capital stock, while the lower graphs depict capital accumulation for firms that start with lower capital stocks (those in the first quartile).

The initial difference in capital stocks between these two groups is very large. The difference in log capital stocks is about 2, which implies that the capital stock is almost ten times higher in this group. However, MSEs that start with lower capital stocks start accumulating while those with a high capital stock even tend to reduce their capital stock over time. After two and a half years, capital stocks in the two groups hardly differ significantly, although average capital stocks are still higher (about three times) in the group that starts with high levels.

Figure 2: Capital accumulation and decumulation of a panel of young firms by initial capital stock



Source: Authors' calculation based on the ENAHO panel-subsample.

We have explained above how credit constraints and risk may cause a gradual adjustment to optimal capital stocks. While the above theoretical considerations suggest that constrained entrepreneurs should approach their steady-state capital stocks from below, Figure 2 illustrates that quite a number of firms appears to start with capital stocks that are too high and are subsequently adjusted downwards. This capital decumulation among young firms may be a sign of misguided profit expectations and/or be linked to realized business failure in risky activities.

The subsequent analysis of both capital accumulation and decumulation in MSEs makes an attempt to shed some light on the causes of these patterns. We draw on the panel-subsample in urban areas as described in 3.1.

Departing from

$$I_{it} = I\left(K_{it}, \Omega_{it}, W_{it}, R_{it}\right) \quad (5)$$

we estimate an accumulation function of the form

$$k_{i\,t+1} - k_{i\,t} = \alpha + \gamma k_{it} + \varphi \omega_{it} + \delta W_i + \mu R_{is} + \beta_{age} age_{it} + \beta_t t + \beta_s S_i + \varepsilon_{it} \quad (6)$$

where all variables are defined as before. In addition to our key variables of interest log initial capital k_{it}, log total factor productivity $\acute{\omega}_{it}$, wealth W_i and risk R_{is}, we control for firm age age_{it} as well as year t and sector S_i effects. Instead of log initial capital k_{it}, the below estimates will assume "conditional convergence" to an optimal sectoral capital stock and hence introduce the difference to the mean sectoral capital stock as regressor. As in our descriptive part above, we proxy wealth W_i by an index based on non-business assets. As indicated by the subscript is of the risk measure R_{is} we use an firm-specific (of firm i in sector

s) proxy for risk, in contrast to most other empirical studies that typically measure risk at the sector level. Such measures, for example the sectoral variation of profits or sales, may well be correlated with other unobserved sector-specific effects. Moreover, even if some sectors may on average be more risky than others, there may be activities within these sectors of low risk. We therefore propose to measure idiosyncratic risk using the time-variant component from the FE estimation of (4). More specifically, we construct a measure of exposure to risk R_{is} of from the residual ε_{it} of the FE estimation as

$$R_{is} = \frac{\sum_{t}^{T} |\varepsilon_{it}|}{T} - \frac{\sum_{j}^{S} \sum_{t}^{T} |\varepsilon_{jt}|}{S}$$

where T refers to the number of periods, in which we observe MSE i, and S to number of MSEs in sector s. This measure based on average absolute time-variant FE residuals intends to reflect only firm-specific volatility in value-added, as we subtract the sector-specific volatility that we capture by the sum of absolute residuals over all firms in this sector. From R_{is} we construct a dummy set to 1 for all firms in the highest tercile of R_{is}.

Equipped with this set of explanatory variables, we now turn to the results of the growth regressions that are shown in first column of Table 8 (Model 1). As expected, the effect of (initial) capital stock is negative, i.e. firms with low levels of capital accumulate faster than those with higher capital stocks. On top of this, there is a negative effect of firm age that would tend to reinforce this “convergence” effect through retained earnings. More productive firms and those of asset-rich entrepreneurs also have a higher capital growth rate while risk has no significant effect. All these findings are in line with expectations and support the hypothesis that MSEs indeed accumulate capital through retained earnings, which in turns is a strong sign of credit market imperfections.

Table 8: Estimated functions of capital accumulation

	Dependent variable: rate of capital growth	
	Model 1	Model 2
Difference from mean	-0.413***	-0.379***
sectoral capital stock[§]	(0.020)	(0.026)
Enterprise age	-0.026***	-0.022***
	(0.008)	(0.008)
Enterprise age^2	0.001**	0.000*
	(0.000)	(0.000)
Log TFP	0.146***	0.148***
	(0.048)	(0.038)
Risk	0.009	0.051
	(0.162)	(0.124)
Wealth	0.096***	0.087***
	(0.015)	(0.012)
Interactions with difference		
- Enterprise age		0.005
		(0.004)
- Enterprise age^2		-0.000*
		(0.000)
- Log TFP		0.029
		(0.023)
- Risk		-0.196**
		(0.077)
- Wealth		-0.004
		(0.007)
Year dummies	Yes	Yes
Sector dummies	Yes	Yes
R-squared	0.229	0.233
N	2126	1987

Source: Authors' calculation based on the panel-subsample from ENAHO.
Notes: Standard errors are bootstrapped with 500 repl., * p<0.10, ** p<0.05, *** p<0.01
[§] measured as the difference between the log capital stock and the sector mean log capital stock

Yet, these results have little to say on why some firms may reduce their capital stocks, as suggested by Figure 2. In Model 2 we therefore additionally interact $\acute{\omega}_{it}$, W_i, R_{is}, and age_{it} with the difference from the mean, i.e. this specification allows the effects of these variables to vary with the distance from the optimal capital stock. The only significant and important effect can be found for the interaction with risk that turns out to be significant and negative. The effect of risk alone is now slightly positive albeit not significant, thus only weakly supporting the hypothesis that risk premia are being reinvested at low levels of capital. At higher levels of capital, however, risk now exerts a strong negative effect on capital accumulation. This implies that the decumulation pattern observed in Figure 2 may be driven by risk.

In sum, the analysis of capital accumulation suggests that MSEs accumulate capital through retained earnings. This reflects that they are indeed credit constrained. The key determinants of returns to capital – the level of capital, total factor productivity, and risk – all exert the expected effect on accumulation. These observations are consistent with high estimated returns to capital at low levels of capital. For firms with a higher than sector-average capital stock, there is weak evidence that this may be related to (miscalculated) business risk.

To corroborate these findings, we now re-estimate the above production functions and include interaction terms with (1) a dummy for asset poor entrepreneurs (those within the first tercile of the wealth distribution), (2) our risk measure defined above and (3) a dummy for very risky activities based on the same measure (firms within the highest risk tercile) . We expect marginal returns to capital in all three groups to be higher than for the respective reference group. And indeed, the parameter estimates and the corresponding marginal returns to capital, which are shown in Table 9, are in line with these expectations. Wealthy entrepreneurs with low levels of capital stock hardly earn any returns on the margin, while entrepreneurs from asset-poor households are able to earn 44 percent monthly marginal return. Firms in high risk-activities also have much higher returns to capital albeit they earn less ceteris paribus.

Table 9: Heterogeneity of returns at low levels of capital stock

	Dependent variable: log value-added		
Dummy	Asset-poor	Risky activities	Risky activities (highest tercile dummy)
Log labor	0.722***	0.658***	0.638***
	(0.028)	(0.023)	(0.025)
Log capital	0.018	0.066***	0.040**
	(0.017)	(0.015)	(0.018)
Dummy	0.144	-1.687***	-0.879***
	(0.255)	(0.560)	(0.289)
Dummy* Log labor	-0.158***	0.150	0.072
	(0.047)	(0.107)	(0.052)
Dummy* Log capital	0.098***	0.139*	0.079**
	(0.029)	(0.076)	(0.035)
Sector-year interaction	Yes	Yes	Yes
R-squared	0.364	0.379	0.382
N	2248	1829	1833
MRK (dummy)	44,06%	n.a.	52,44%
MRK (not dummy)	8,95%	n.a.	17,90%

Source: Authors' calculation based on the panel-subsample from ENAHO, restricted to MSEs with a capital stock of up to 100 USD.

Note: Standard errors are bootstrapped with 500 repl., * p<0.10, ** p<0.05, *** p<0.01

Conclusions

In this paper, we analyze returns to capital, productivity and dynamics of MSEs using a unique panel dataset from Peru. The observed behavior is generally consistent with a dynamic MSE sector where credit constrained firms operate in risky business environments. We find a number of signs that entrepreneurs are severely credit constrained and that risk plays an important role in explaining returns and hence firm dynamics.

We estimate a production function using simple OLS. Marginal annual returns are very high at low levels of capital, but rapidly decrease rapidly with higher levels of capital. This result is robust to the estimation method applied as shown by estimating a fixed-effects model and applying a semiparametric procedure proposed by Levinsohn and Petrin (2003). We find these high returns to capital to be strongly driven by firms that are credit constraint and exposed to high risks, but still constituting potentially successful entrepreneurs.

The analysis of capital accumulation suggests that MSEs accumulate capital through retained earnings. This again reflects that they are indeed credit constrained. The key determinants of returns to capital – the level of capital, total factor productivity, and risk – all exert the expected effect on accumulation. These observations are consistent with high estimated returns to capital at low levels of capital. We also find evidence for firms decumulating capital and some weak evidence suggests that this may be related to (miscalculated) business risk. Taken together, the findings once again illustrate the great heterogeneity of informal activities. The dynamics of an important part of small-scale activities, however, resemble those of MSEs in more advanced economies, more so if conditioned on the constraints under which MSEs operate.

From a policy perspective, these results imply that credit constrained and risk leave the potential of many small-scale entrepreneurs unexploited, thus providing a rationale for policy interventions, such as micro-credit programs. These policy interventions should also target entrepreneurs with very low levels of capital that have often mistakenly been considered subsistence-oriented entrepreneurs.

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