Do Entry Costs Provide an Empirical Basis for Poverty Traps? Evidence from Mexican Microenterprises[#]

David J. McKenzie[*] and Christopher Woodruff[**]

** Development Research Group, The World Bank*
MSN MC3-300, 1818 H Street N.W.
Washington, D.C. 20433, USA
E-mail: dmckenzie@worldbank.org
Phone: (202) 458-9332
Fax: (202) 522-3518

*** Graduate School of International Relations and Pacific Studies, UCSD*

We thank two anonymous referees, John Strauss, Dilip Mookherjee, Jim Rauch, Christopher Udry and participants at seminars at the University of Southern California, the University of California, Berkeley, Stanford University, and the World Bank for their helpful comments and suggestions and Bill Maloney for help using the ENAMIN data. The views expressed here do not necessarily reflect those of the World Bank or its member countries.

Abstract

Recent theoretical literature in development economics has shown that non-convex production technologies can result in low-growth poverty traps. This paper uses detailed microenterprise surveys in Mexico to examine the empirical evidence for these non-convexities at low levels of capital stock. While theory emphasizes non-divisible start-up costs which exceed the wealth of many potential entrepreneurs, this paper shows start-up costs to be very low in some industries. Semi-parametric methods are then used to flexibly estimate returns to capital in microenterprises. Much higher returns are found at low levels of capital stock than at higher levels, and this remains true after controlling for firm characteristics and measures of entrepreneurial ability. Overall, little evidence of production non-convexities is found at low levels of capital. The absence of non-convexities is a significant finding because it suggests that access to startup capital does not determine the ultimate size of the enterprise.

JEL Classifications: O12, J23, J62, D31.

Keywords: non-convexities, poverty trap, start-up costs, microenterprises.

1. Introduction

There is a growing body of theoretical work concerned with the interaction between capital market imperfections and non-convex production technologies.[1] Banerjee and Newman (1993), for example, develop a dynamic model with risky investment projects requiring an indivisible start up cost which exceeds the wealth level of at least some of the agents in the economy. Low-wealth entrepreneurs are unable to finance profitable ventures. Entrepreneurial activity involving a minimum wealth level is also a feature of the models of Aghion and Bolton (1997) and Lloyd-Ellis and Bernhardt (2000).

In combination with poorly functioning credit markets, the nonconvexities have several implications. First, there is too little entry of new firms. Second, production is inefficient because some of the most talented entrepreneurs cannot obtain the amount of capital necessary to overcome minimum scale investments. Third, the incentive for the poor to save is reduced because nonconvexities result in low returns to low levels of invested capital, and poorly functioning capital markets result in low returns to financial savings.

The models, then, have important implications for the path of development. They imply that an economy may land in a low-growth poverty trap from which those with little capital to invest can neither bootstrap their way up by reinvesting profits over time nor borrow their way above the minimum scale. Relaxing either of the assumptions generally eliminates the poverty trap outcome.[2] In particular, if production technologies are convex, then initial conditions will not affect the long run path of the economy.

In this paper, we take as given the possibility that some individuals may be credit-constrained and test whether self-employment production technologies contain indivisibilities which place credit-constrained individuals in poverty traps. More specifically, we examine whether minimum start-up costs are high relative to wealth and if returns to capital are low at low investment levels. That is, do production non-convexities prevent entry to self-employment or result in low returns from entering with small amounts of capital?

Using data from an extremely detailed survey of microenterprises in Mexico, we first show that the median investment levels of new firms in some sectors are very low, less than US $100 in construction and personal services, an amount less than half of monthly earnings of even a low wage worker. Next, we show that the marginal return to capital invested in these sectors is quite high for low levels of invested capital. We have a large sample of microenterprises and so are able to use semi-parametric estimation methods which allow the returns to vary flexibly over the range of capital stock. We find that returns to capital are 15 percent a month for investment levels below US$200, substantial for investment levels below US$1000, and more moderate for investment levels above $1000. Returns are always positive, and while our point estimates indicate increasing returns between $1000 and $2000 of capital, the estimates are not precise enough to statistically reject that returns are non-increasing. While our focus is on the marginal returns, we also show that people who are self-employed earn more than a wage equation would predict, so that people who enter with small amounts of capital are also doing better than they would in the wage sector.

Our estimates of returns to invested capital at capital stock levels in excess of about $500 are in line with interest rates charged by microfinance organizations and other lenders, which range up to 5 percent per month. The higher returns experienced by low capital firms are more puzzling. We consider several possible explanations for the very high rates of return. First, we consider the possibility our estimates may be biased upward due to a lack of controls for differences in entrepreneurial ability. The microenterprise data we use are cross sectional, and hence we are not able to control for ability with individual fixed effects. Instead, we use the panel labor market survey from which our microenterprise survey is drawn to obtain three measures of entrepreneurial ability, which are discussed in more detail later in the paper. We find there is indeed a positive correlation between measures of the entrepreneur's ability and firm earnings. However, inclusion of the ability controls does not result in a marked change to our estimates of marginal returns to capital.

Next, we explore the possibility that capital constraints, learning, or differences in risk, may explain the high returns to capital. Entrepreneurs receiving the highest returns are found to be those with lowest wealth and for whom capital constraints may apply. We also find that the variation in earnings increases and the return to capital decreases with the level of invested capital stock, suggesting that the high returns do not reflect compensation for increased risk.

The modest median investment levels and the high returns to small capital investments suggest that non-convex production technologies play no role in preventing entry into the microenterprise sector. The absence of non-convexities and pattern of positive returns is a significant finding because it suggests that access to startup capital does not determine the ultimate size of the enterprise. Given the pattern of returns to capital we find, entrepreneurs without startup capital can pull themselves up by their bootstraps by reinvesting their profits.

We note two caveats to these rather optimistic findings. First, the data suggest that non-convexities may be important in certain sectors of activity, especially transportation and professional services. These are the sectors in which returns to capital appear to be highest at higher levels of invested capital. Thus, the "bootstrapping" strategy may have limits if there are costs of switching sectors of activity. Second, as we noted above, there is some suggestion in the data of non-convexities in the \$1000-\$2000 range. This suggests the possibility of a hurdle which must be overcome along the firm's growth path. Levy (1993) suggests the possibility of a threshold effect, whereby fiscal and bureaucratic costs are only faced by firms above a minimum size. Banerjee (2003) notes that non-convex costs may also arise from hiring labor, due to monitoring costs. This paper is unable to rule out the possibility that such non-convexities prevent small businesses from becoming larger, suggesting that future empirical work on poverty traps should examine larger firms.[3]

In comparison to the theorists' level of interest in nonconvexities, there has been relatively little empirical work examining the returns to investment among microenterprises. This is due at least in part to a lack of data. Surveys which include data on investments and profits of microenterprises are still relatively rare. Hill and Kalirijan (1993), Bigsten et al. (2000), and Hernández, Pagán and Paxton (2005) are the closest studies we are aware of to our own. Hill and Kalirijan (1993) estimate returns to capital in the Indonesian garment industry, using a sample of 2250 firms taken from that country's Census of Small Industry. Bigsten et al (2000) use data from surveys of manufacturers in 5 African countries. Hernández, Pagán and Paxton (2002) use the same data we do to estimate the technical efficiency of the firms. All of these studies find high rates of return to invested capital. These studies do not speak directly to the question of nonconvexities, however, because each specifies a translog production function. Given the range in size of firms included in their studies, the translog specification smoothes the data too much, potentially masking important variation in marginal returns to capital across levels of capital investment.

Several studies of African enterprises have addressed the related question of whether firm size is related to firm growth. Liedholm and Mead (1999) find that, on average, small firms have faster employment growth than larger firms, but that most small firms do not change employment levels. Data from the RPED panel survey of manufacturing enterprises in seven sub-Saharan Africa countries also reveals that micro firms have the fastest employment growth rates (Biggs and Srivastava 1996). However, after controlling for firm age and lagged size, van Biesebroeck (2005) used the RPED firm panel and recently found that larger firms have higher levels of growth in employment, value-added, and productivity. The RPED panel is limited to manufacturing firms with three or more employees, and its micro firms are still larger than the enterprises considered in this paper. Moreover, there need not be a one-to-one relationship between firm growth rates and marginal returns to capital, since household needs may lead smaller firms to reinvest a smaller share of profits.[4] Nevertheless, such studies echo the caution above about the possibility of threshold effects beginning to operate as firms start hiring workers, potentially leading small firms with some workers to have lower growth rates.

Previous surveys of micro enterprises also provide descriptive evidence suggesting that access to capital to fund lumpy investments is not among the most severe problems faced by firms surveyed in Africa and the Caribbean (Liedholm and Mead 1987, 1999). Data from surveys conducted in five African countries by Liedholm and Mead (1999) indicate that access to capital was identified as the major problem facing the business in only one-quarter of urban firms. But, where capital was listed as a major problem, the issue was most commonly working capital rather than fixed capital. Only 5.6% of urban firms identified access to fixed capital as the major problem facing their business.

A second related empirical literature examines how the occupational choice of workers is affected by access to investment capital. Evans and Jovanovic (1989), and Blanchflower and Oswald (1998) find an association between entry into self employment and an individual's assets using data from the US and Great Britain, respectively. Paulson and Townsend (2004) find that having more household assets makes entry into self employment more likely in Thailand. Mesnard and Ravallion (forthcoming) find a concave effect of migrants' savings on entry into self-employment in Tunisia. These studies may be interpreted as providing indirect evidence of the presence of a minimum scale of production. However, these studies do not necessarily imply non-convex production as there may be credit-related or risk aversion explanations for the relationship found. Moreover, these studies do not provide estimates of the marginal returns to capital at low levels of investment.

There is also a recent literature which looks for evidence of poverty traps by examining changes in household income over time. Jalan and Ravallion (2004) find non-linearities in income dynamics in rural China, but no evidence of dynamic poverty traps, while Lokshin and Ravallion (2004) reach similar findings in Hungary and Russia. The intention of the current paper is different in focus. We do not and can not attempt to say whether poverty traps exist at all, but rather can rule out that they are caused by non-convexities upon entry into self-employment. Credit constraints can restrict the amount of capital available to prospective entrepreneurs, but we find that entry costs are low enough and returns to capital high enough at low levels of capital stock that there is no entry-level poverty trap.

The remainder of this paper is structured as follows. Section 2 examines the importance of non-convexities for entry to self-employment. Section 3 discusses semi-parametric estimation of marginal returns to capital and provides results at the aggregate and industry level. In Section 4 controls are made for ability bias and evidence is provided on income growth for different capital stock ranges. Several explanations for the high returns to capital at low capital stocks are offered in Section 5, while Section 6 concludes. Appendix A provides more detail on construction of the data.

2. How Important are Startup Costs?

We use data from Mexico's National Survey of Micro Enterprises (ENAMIN), gathered in 1992 (1st quarter), 1994 (1st quarter), 1996 (1st quarter), and 1998 (4th quarter). The survey samples firms with 5 or fewer workers, except in manufacturing, where the upper limit is 15. The survey is representative of all urban areas with populations of 100,000 or more (INEGI, 2000). Cities with more than 100,000 inhabitants contained just under half (46%) of Mexico's population in 1998. The ENAMIN sample is drawn from Mexico's quarterly urban labor survey (the ENEU), which is itself a household-based survey using the Mexican Population Census as its sampling frame. This survey design captures unregistered, informal, enterprises in addition to registered enterprises. The resulting survey is more representative of micro enterprise than other surveys which draw samples from industry association lists, leading to a bias towards larger, more successful firms. About 10,000 firms were surveyed in each of the 4 years. We focus in this paper on firms owned by males, which represent about two-thirds of the firms in the sample[5], and whose owners are between 18 and 65 years of age and who work full time (35 or more hours per week). While there are minor differences in the survey instruments, the data appear to be comparable across the 4 surveys. We translate all peso value responses to 1998 $US, using the Mexican GDP deflator and the peso/dollar exchange rate for the 4th quarter of 1998.[6] The data are described in more detail in Appendix A.

A potential concern when using data from microenterprises is the accuracy of reporting of sales and capital stock data by firm owners who often do not keep formal business accounts.[7] The two main variables of interest are business profits and firm capital stock. Classical measurement error in profits will merely add additional noise to our estimation, and not affect the consistency of our results. Firm owners often have a reasonable idea as to the replacement value of their capital stock, and so we expect less measurement error in this than in recall of profits. To the extent that capital stock does suffer from classical measurement error, this will tend to attenuate the estimated marginal return to capital towards zero in our local linear estimation, causing us to understate the returns to capital. Moreover, since the measurement error is likely to be proportionately more important for the smallest firms, measurement error should lead to more attenuation bias in the locally estimated returns at low capital stock levels than at higher capital stock levels. As a result, such measurement error, if anything, serves to strengthen our conclusion of higher returns to capital at low capital stock levels.

There is little formal financial intermediation among the ENAMIN firms. Less than 1% report receiving start-up financing from a banking institution and less than 6%

report ever having had a bank loan. A priori, then, there is reason to expect that capital constraints may be binding.

Table 1 examines the importance of start-up costs in generating non-convexities for microenterprises in Mexico. In Panel A we inspect the distribution of capital stock by industry for firms which have been in existence for two years or less. Large differences are seen across industries. In construction and personal services, 24% and 47% of firms report that no initial funding was needed to begin the business, with the lower quartile of firms in these industries having total capital stock less than $US 47. In contrast, manufacturing, trade, and transportation require much bigger initial outlays. Less than seven percent of firms in these industries report that no initial funding was needed, while the 25th percentile of capital stock is $US 281 for manufacturing, $US 329 for trade, and $US 2070 for transportation.

To illustrate the importance of these start-up costs relative to income levels, we calculate for each industry the number of months of earnings the 10th and 25th capital stock percentiles represent. The last four columns of Panel A report this in terms of both the tenth percentile (low wage) and the median of the earnings distribution for wage workers in the fourth quarter of 1998. In personal services and construction, the 25th percentile of industry capital amounts to only 0.1 and 0.4 months of low wage earnings, compared to 2.6 months for manufacturing and 19.3 months for transportation. In other words, a low wage worker saving 10% of his income would require only one to four months to acquire sufficient capital to enter the construction and personal services sector at the 25th percentile of capital stock level, 9 months to enter repair services, 31 months to enter trade, 50 months to enter professional services, and 193 months to enter the transportation industry[8]. Under a 10% savings rate, even a median wage worker would require 41 months of saving to enter the transportation industry at only the 10th percentile of industry capital.

In addition to the costs of physical capital, start-up costs may include labor and monitoring costs for hired workers (Banerjee and Newman, 1993), search and permit costs for leasing premises, contracting costs for acquiring inventories[9], and the bureaucratic costs of registering and dealing with government and other agencies (Levy, 1993). The dollar amounts of these types of start-up costs can be difficult to measure, so in Panel B of Table 1 we simply report the percentage of firms in each industry who do not face these costs. Again construction and personal services seem to be the lowest start-up cost industries, with the majority of firms in these sectors not subject to any of these additional costs. Transportation, professional services, and trade are all more subject to bureaucratic requirements, and in addition may require acquiring premises and inventories prior to start-up.

From Table 1 we conclude that fixed costs are unlikely to be an important source of non-convexity in terms of providing barriers to entry into self-employment. However, access to startup capital may affect the particular industry a given entrepreneur chooses to enter. Entry into the construction, personal services and repair services industries requires very little physical capital, involves low bureaucratic obstacles, and does not require hiring paid workers or obtaining formal business premises.

3. Returns to capital

Having entered self-employment, entrepreneurs may be confronted with non-convexities in production. Banerjee (2001, p.34) remarks that "non-convexities in production are certainly very plausible", since "most machines have a minimum efficient scale, and rental markets are at best an imperfect substitute". The presence of these non-convexities can lead to poverty traps in theoretical models. Furthermore, if returns to capital are low at low levels of investment, then the poor get low returns, reducing their incentive to save and thereby reinforcing the poverty trap.

We begin by examining the returns to capital in the cross-section of entrepreneurs. Because returns may be either increasing or decreasing in the level of capital invested, it is important to allow the returns to capital to vary according to the level of capital employed, and so earnings of the self-employed are modeled semi-parametrically. A fifth-order polynomial in capital is also estimated for comparison purposes. Let π_i denote the monthly earnings of self-employed worker *i*, given by the response to the survey question: "How much did you make in profits, after subtracting expenditures." Let K_i be the non-rented capital stock employed by the firm, measured as the replacement cost of real estate, machinery, tools, vehicles, and other equipment owned by the enterprise, plus the value of any inventories and work in progress.[10] Finally, let Z_i be a vector of other variables which potentially affect earnings, such as the age and education of the entrepreneur. We motivate the variables included in Z_i below. The self-employment earnings function is then modeled by a partial linear model:

$$\pi_i = h(K_i) + Z_i'\beta + \varepsilon_i \qquad (1)$$

Our focus will be on the derivative of the function h(.), which provides marginal returns to capital. Semi-parametric estimation of equation (1) is carried out in two steps. First, the parameter vector β is estimated using the higher-order differencing method of Yatchew (1997), with a differencing order of five. The data is sorted in ascending order of the capital stock K_i. Let $d_0, d_1, \ldots, d_5$ denote the optimal differencing weights given in Yatchew (1998, p. 697). Then β is obtained by least squares estimation of the equation:

$$\sum_{j=0}^{5} d_j \pi_{i-j} = \left(\sum_{j=0}^{5} d_j Z_{i-j} \right)' \beta + \eta_i \qquad (2)$$

This fifth-order differencing achieves 91 percent efficiency relative to the asymptotic efficiency bound and does not require nonparametric estimation to estimate β. Let $\hat{\beta}$ be the estimate of β obtained from (2). Then the second step in estimation is to use non-parametric methods to estimate the function *h(.)* and its derivative in the equation:

$$\pi_i - Z_i'\hat{\beta} = h(K_i) + v_i \qquad (3)$$

Estimation of equation (3) is carried out using the local linear regression of Fan (1992). In addition to certain optimality properties, this estimator is particularly desirable for our purposes as it provides for easy estimation of the derivative of the function *h(K)* along with the function itself, providing the marginal returns to capital. We use cross-validation to select the optimal bandwidth and the Epanechnikov kernel following the recommendations of Fan and Gijbels (1996).

Some further discussion of the variables included in the vector Z is warranted. The cross section of enterprises in our sample is the outcome of individuals' decisions to enter into and remain self employed. The alternative to self employment is work in the wage sector. Hence, we expect the level of profits to be related to wages in the labor market. We measure the alternative opportunity with the average wage of full time workers in the industry and state in which the individual works. (The industries are the nine shown in Table 1.)

Profit rates will also be affected by the ability of the entrepreneur. Our primary specification measures the individual's productive ability with years of schooling and age. We include a variable indicating that the owner is married as labor economists have found that married workers generally earn higher wages, after controlling for other characteristics. Ginther and Zavodny (2001) review the various explanations and, using data on shotgun weddings, find that most of the male marriage premium represents a direct productivity effect of marriage rather than a selection effect. We also include the number of hours the owner normally works in the enterprise.

About 19% of the enterprises employ unpaid family members. Since these workers are unpaid, we expect the profits from their efforts to accrue to the owner. We include the number of hours normally worked in the enterprise by unpaid workers. Returns to managerial ability are measured by including the number of hours worked by paid employees. Finally, firms are more likely to remain in business if they are more profitable. Therefore, we include a measure of the age of the firm and its square. We also include indicators of the year in which the survey was undertaken (with 1998 as the base year) and the industry in which the firm operates (with construction as the base industry).

Table 2 reports the estimates of the controls in equation (2) using data from all industries and years combined.[11] Returns are estimated separately for low capital ($0-$1000 of capital) and higher capital firms ($500-$5000). We have about 7000 observations in the low-capital sample and 5000 observations in the high-capital sample.[12] Parametric estimation of equation (1) using a fifth-order polynomial in capital in place of *h(K)* is also provided.[13] Results for two specifications are provided. The first (Model i) specification includes the measures of the owner's age, education and marital status, the age of the firm, and the number of hours worked by paid and unpaid employees. The second (Model ii) adds year and industry effects to Model i. The labor hours of the owner has at most a weakly significant positive impact on earnings, while the owner's age only has a significant effect on earnings for low capital firms. Earnings increase with firm age until the firm is 26-36 years old, after which earnings start to fall. This may reflect either the selection effect mentioned above or learning by young firms . The education of the owner, which partially reflects ability, has a strong positive and nonlinear effect on earnings. College education results in substantially higher earnings than any other education level. Married owners earn more. Both unpaid and paid labor increases earnings, though paid labor has a much larger impact. Each (weekly) hour of paid labor increases the entrepreneur's earnings by about US$1 a month. The prevailing wage in the labor market has a highly significant positive effect as expected. The industry and year effects are significant and so we work with Model ii for the remainder of the paper.[14]

Figure 1 displays the returns to capital found from estimating equation (1) without any controls and returns estimated from the models in Table 2. Adding controls reduces the estimated returns, with Models i and ii providing similar results. Returns to capital are found to be extremely high at low levels of capital. Measured characteristics of the owner, workers, and firm account for only a portion of this high return. We find returns of above 20 percent per month for capital stock below \$200 even after controlling for these measured characteristics. Returns to capital fall to around 5 percent per month for capital stock of \$400-800. Returns to capital are increasing over capital stock ranges \$100-200 and \$400-600, providing some evidence of non-convexities in these capital ranges. However, returns remain positive over the \$0-1000 range of capital, and the high returns at low levels of capital do not suggest a pattern which would be expected to produce a poverty trap.

The lower half of Figure 1 provides returns to capital when the capital stock is in the \$500-\$5000 range. Returns are decreasing over the capital stock range \$500-1000, but then increase to around 5 percent for capital stock of \$2000. Some evidence of non-convex technology is again seen in returns increasing over the ranges \$1000-1500 and \$3000-5000. The parametric returns show the same general shape as the semi-parametric returns after \$1500, although with more variability and more dependence on the range of estimation. Returns remain non-negative, suggesting that non-convexities are not strong enough to cause a range of negative returns to capital. The results thus suggest that incremental changes in capital stock will generally provide positive returns.

The local linear returns in Figure 1 show some regions of increasing returns. To examine whether these non-convexities are significant, we carry out 100 bootstrap replications of the semi-parametric estimation of model ii, and plot the estimated 95% pointwise confidence intervals in the top half of Figure 2. Although the bandwidth used for smoothing is chosen by cross-validation to be the optimum, we see quite wide confidence intervals around the estimated returns, and one can not reject that returns are non-increasing over the entire capital stock range up to \$5000. In the lower half of Figure 2 we trade off some bias for lower variance, oversmoothing the returns. Over the low capital region we find the non-convexity smoothed out, and narrow bands around the high returns at capital levels below \$200, with returns averaging 4.5% in a confidence interval of 2-7% for capital stock $500-1000. For the returns with higher capital, there is still some slight suggestion of increasing returns between $1000 and $2000 after more smoothing, but one can still not reject non-increasing returns over this region. We therefore conclude that there is little support for non-convexities in the returns to capital below $1000, and only weak evidence for non-convexities in returns to capital above $1000.

One possible explanation for the pattern of returns found in Figure 2 is that returns differ across industries and that combining disparate industries might produce misleading estimates of returns to capital. We investigate this by reestimating model ii in Table 2 separately for six different industries.[15] Local linear returns were estimated between the 5th and 80th percentiles of industry capital stock, and the parametric returns between the 5th and 85th percentiles of capital stock. The dollar value of the upper cutoff thus differs by industry, ranging from $673 for construction to $14,641 for transportation. The number of observations available for estimation ranged from 2448 for trade to only 691 for professional services.

Figure 3 plots the estimated returns by industry. In four of the six industries—construction, repair services, trade and manufacturing--the pattern of returns is very similar to that found in the entire sample. Returns to marginal investments at low levels of capital exceed 20% per month. The returns decline precipitously, falling below 10% per month at investment levels of $500.[16] In trade, we find a range of increasing returns, as was found when industries were combined. Returns in the more highly capital intensive industries--transportation and professional services—show a markedly different pattern, remaining always in the 2-3% range. This implies a much lower rate of return in these industries among firms investing small amounts, and comparable or higher rates of returns among firms investing larger amounts. The fact that we observe very few firms in construction and repair services with high levels of capital stock would seem to suggest that returns to capital are very low at high capital levels in these industries, however this same lack of observations prevents us from estimating returns at high capital levels. It may be necessary for entrepreneurs to switch to high capital industries such as transportation and professional services in order to earn returns on larger amounts of capital stock. Overall, the results from industry-level estimation do not suggest that the returns patterns found in Figure 2 arise from aggregation across industries, and, in particular, high returns at low levels of capital stock are found in several industries.

Of course, a non-convexity could occur precisely at the point of zero capital as well, and thus not be reflected in the marginal returns to capital. That is, earnings in self employment could be lower than wage earnings in wage work, even though the marginal return to capital in self employment is high. To check for this possibility, we calculate a predicted wage for each entrepreneur in the sample, given his age, education, and sector of employment. We find no evidence of a self employment earning penalty. Even entrepreneurs with very low levels of invested capital (less than $50) earn more on average than wage earners with similar measured characteristics.

4. Returns and Entrepreneurial Ability

The returns estimated above are based on differences in capital investment across enterprises. The estimated returns are subject to bias from two sources. First, the level of capital invested in the enterprise may be correlated with the profitability of investment opportunities. Second, the level of capital investment may be correlated with the entrepreneurial ability of the owner. In this section, we explore the nature of these possible biases, and describe the manner in which we address them.

The first potential bias in estimated returns to capital comes from the possibility that entrepreneurs operating in more profitable markets will invest more in their enterprises. In this case, the measured increase in profits associated with an increase in capital stock would reflect both the true marginal productivity of capital and the correlation between capital stock and the profitability of the market. The difficulty in measuring the profitability of the investment opportunities of a given firm is a central concern in the literature on capital constraints and investment (see Fazzari, Hubbard and Petersen, 1988). The credit constraint literature has generally used data from firms which are orders of magnitude larger than the ones in our sample. Large firms might maintain competitive advantages for long periods of time, while our firms are unlikely to do so. Given the small size of the firms in our sample, and the absence of barriers to entry, we expect the long run profitability of firms in our sample to converge to some common level. The opportunity to make profitable investments will be affected by short term shocks which might vary across the locations and industries in which the firms operate. We have controlled for industry/location specific shocks to some extent with the inclusion of the average wage in the state and industry in which the firm operates.[17] The significance of this variable indicates that shocks to wages are reflected in profit rates.

A second source of bias, which may be of greater concern in our data, comes from the possible correlation between the investment level and the unmeasured ability of the entrepreneur.[18] Theory does not provide clear guidance with regard to the direction of this bias. Depending on the specification of the theoretical model, ability may be either positively or negatively correlated with the level of invested capital. Hence, in the presence of capital constraints, an imperfect measurement of entrepreneurial ability may produce either an overestimate or an underestimate of the returns to capital. To see this, assume that higher ability entrepreneurs earn higher profits and, as is commonly assumed, entrepreneurial ability and physical capital complement one another. Then the marginal returns to capital will be increasing in ability. Formally, this is represented by adding ability to the profit equation as follows:

(1a) $\pi_i = \theta_i \, h(K_i) + Z_i'\beta + \varepsilon_i$

where θ_i measures the entrepreneurial ability of the ith individual. Ignoring capital constraints and assuming all entrepreneurs in our sample have the optimal capital stock given their ability, then our estimates of returns to capital will be biased upward in the absence of measures of ability. The increased profit resulting from an increase in capital will reflect partly the marginal profitability of capital and partly the concomitant increase in entrepreneurial ability.

Note that if ability increases profits without increasing marginal returns, then the proper specification of Equation 1 is:

(1b) $\pi_i = h(K_i) + Z_i'\beta + \theta_i + \varepsilon_i$

In that case, the optimal capital stock will be uncorrelated with ability, and hence not a source of bias in the returns.

In the presence of capital constraints, however, entrepreneurs may operate with capital stocks below their optimal level. Under these conditions, the ability bias may run in the opposite direction. The potential for negative bias comes from the fact that at very low levels of wealth (and hence, capital available for investment), entrepreneurs of very high ability are more likely to find entry into self employment profitable than are entrepreneurs of more modest ability. As capital constraints are progressively relaxed, entrepreneurs of more modest ability will find entry into self employment profitable. In the presence of severe capital constraints, then, there may be a negative correlation between ability and the level of invested capital. Evans and Jovanovic (1989) find a negative correlation between wealth and ability in a sample of self employed workers in the US.

We address these concerns first by including in the regressions variables which are likely to be correlated with ability. Following the lead of Lam and Schoeni (1993), we use the education levels of relatives by marriage as an indication of the unmeasured ability of workers. Lam and Schoeni motivate the connection between the unmeasured ability of a worker and the education of his in-laws with a marriage matching model, in which higher ability individuals attract more desirable mates. (Education is a desirable trait for a mate to have in their model). Using Brazilian data, they show that the education level of a worker's spouse and parents-in-law are all associated with higher earnings. For the subsample of entrepreneurs with a spouse present (about two-thirds of the original sample), we are able to include controls for the level of education of the spouse.

Secondly, the ENAMIN survey asks the entrepreneur what his main motive was for starting his business. Individuals with a family tradition in a business may have learned business skills from their family. Individuals who enter business to achieve higher incomes than in the wage sector may also have higher entrepreneurial ability. In contrast, individuals who begin a business because they can not find wage work or have been laid off from their jobs may have lower ability. Dummy variables for the different motives for starting an enterprise therefore provide a very crude measure of ability, but do have the advantage of being available for the whole sample.

Finally, for recent entrants to self-employment we are able to provide a more direct indication of the entrepreneur's unmeasured ability. As discussed in Appendix A, the sample to which the ENAMIN is administered is drawn from Mexico's quarterly labor survey (the ENEU). Households remain in the labor survey for a total of 5 quarters. By matching the ENAMIN sample to the ENEU, we are able to obtain information about the employment and earnings of the ENAMIN owners in the quarters leading up to the ENAMIN survey and in the quarters following the survey. For example, about one-fifth of the individuals surveyed in the ENAMIN conducted in the 4th quarter of 1998 were first surveyed in the ENEU in the 4th quarter of 1997. Some of these individuals were wage workers in the earlier quarter, shifting into self employment during 1998. For these individuals, we take the difference between actual wages earned in the labor market and the wage predicted by a wage regression as an indication of the individual's productive ability. This is calculated by first estimating a wage regression for all of the full time male wage workers in the ENEU (the overwhelming majority of which are not included in the ENAMIN sample). The wage regression is of the form:

$$W_i = X_i^{'}\gamma + \eta_i \tag{5}$$

where X_i includes the average wage in the industry and state in which the individual works, the individual's education and its square, estimated work experience (age minus education minus six) and its square, and the hours worked and its square. We use the coefficients from this regression to obtain a predicted wage for each of the individuals in the ENAMIN sample who were wage workers during at least one of the quarters prior to the ENAMIN survey. Due to the high rates of entry into self employment in Mexico (see Maloney, 1999), we have wage market data for about 2000 male owners who are included in the ENAMIN surveys.

The wage regression controls for some factors affecting the productivity of workers (e.g., years of schooling and work experience). As with the profit function, however, a more complete wage determination equation is given by:

$$W_i = X_i^{'}\gamma + \omega_i + \eta_i \qquad (6)$$

where ω_i measures the ability of the individual which is not associated with learning in school or on the job. In the absence of explicit measures of ω_i, ability is embedded in the wage residual η_i.[19] We thus take η_i as correlated with labor market ability. If we assume that labor market ability and entrepreneurial ability are positively correlated, then η_i will also be correlated with θ_i. Clearly, η_i is an imperfect measure of θ_i, but we expect the two ability levels to be strongly correlated.[20]

Table 3 reports the result of semi-parametric regressions adding the education of the entrepreneur's spouse, the entrepreneur's reason for beginning the business, and their own wage premium (for recent entrants), to specification *ii* reported on Table 2. Each of the additional variables is available for only a part of the sample. In order to isolate the effect of adding the additional variables, we report a base model (Model *ii* of Table 2) using only those observations for which the additional variables are available. Model A (Columns 1 and 2) shows that entrepreneurs with more highly educated spouses do have higher earnings. This is particularly true if the spouse has college education. To the extent that this reflects entrepreneurial ability, we do find that higher ability leads to greater earnings. However, including spousal ability lowers median returns for those with capital stocks in the \$0-200 only very modestly, from 16.2 percent to 15.8 percent. Estimated returns over other capital stock ranges are similarly impacted. Model B shows that among recent entrants, each dollar of wage premium they received as a wage worker translates into 12 cents of higher earnings as an entrepreneur. When we include both spouse's education and the average wage premium (Model C, Columns 5 and 6), we find only the latter to be significant. Returns in the \$0-\$200 range are unaffected by the inclusion of the controls added in Model C, being 16.0 percent when the controls are included and 16.1 percent when they are not. The reason for beginning a business also has an effect on earnings. Model D shows that entrepreneurs who entered the business to increase income over wage work or because of family tradition[21] obtain higher earnings as entrepreneurs. The ability controls again have only a modest impact on the estimated returns to capital, with returns in the \$0-\$200 range falling from 24.3% to 22.9% when they are included. Thus, Table 3 suggests that while our proxies for ability are not perfect, they do appear to provide some measure of ability, as they are associated with higher earnings. The fact that these measures of ability do not have large effects on marginal returns to capital provides some support for the idea that the high return to capital identified in the regressions is not simply a conflation of investment level and entrepreneurial ability.[22]

The regressions in Table 3 implement equation 1b. They allow for ability to affect the profit level, but not the marginal profitability of capital. The primary reason for this is practical. Even the relatively large sample of firms we have is not enough to enable us to fully estimate a semi-parametric version of equation 1a. We can, however, at a more aggregate level, allow for ability to impact the rates of return to capital by estimating the semi-parametric returns on subsamples of high ability and low ability entrepreneurs. We first examine the subsamples of those owners whose spouses have less than 6 years of schooling and those whose spouses have more than 6 years of schooling.[23] Among firms with less than \$200 in capital, the returns are slightly higher for owners whose spouses have less than 6 years of schooling (20.5%) than among those with more educated spouses (18.3%). At slightly higher levels of invested capital ($200-$500), returns are higher for owners whose spouses have more education (14% vs. 9.6%). A similar pattern holds when we divide the sample by the owner's own education. The median return to capital in the very low investment range (capital < $200) is 20.3% among owners with lower education (less than 6 years), somewhat higher than the 15.8% return among owners with more education (9 or more years). Returns in the $200-$500 range are higher among the owners with more education (8.9% vs. 3.2%). The high ability entrepreneurs in the lowest capital range are those most likely to be capital constrained, and hence subject to negative bias. In spite of this, we find returns among this group of entrepreneurs which exceed 15%.

In sum, the returns to capital among the enterprises in our sample do not indicate the presence of nonconvexities over any broad range of capital investment levels. After adding controls for entrepreneurial ability, we find that returns to capital are highest--around 15% per month-- for investments of less than $200. Returns fall to between 7% and 10% for investments of $200-$500, and to around 5% for investments of $500-$1000.

4.1 Additional Robustness

These findings are robust to a variety of changes in the sample and to changes in the measurement of the dependent variable itself. For example, one source of potential concern is mis-measurement of capital and earnings by entrepreneurs. The ENAMIN contains a detailed business capital module, which separates assets into tools, machinery, furniture and fixtures, business vehicles, premises, and other sources of capital. Within each category, the owner is asked whether items were acquired new or used, whether they are owned, rented or borrowed, and their replacement cost. The low levels of capital reported in some firms are therefore unlikely to be due simply to omitted capital categories. To further allay under-measurement concerns at low levels of capital, we examine in Table 4 how sensitive our results are to dropping the bottom five, ten, and twenty-five percent of capital stock observations among firms with capital stock less than \$1000.[24] Since the controls for entrepreneurial ability do not materially affect the results, we use the basic model with controls (Model ii) of Table 2 in order to maintain a larger sample size. Dropping the lowest five or ten percent of capital stock observations is found to have very little effect on the estimated returns at low levels of capital.[25] Even when we drop twenty-five percent of the capital stock, dropping firms with capital of less than \$61, returns are estimated to be 14 percent per month over the \$61-200 capital stock range.

The measure of firm profits used in this paper is a direct one, given by the entrepreneurs' answer to the question "how much do you obtain as earnings after deducting expenses?". The survey also contains detailed questions on business revenues and expenses. Table 7 also examines the sensitivity of our results to using revenue less expenses rather than reported earnings as the measure of profits.[26] The correlation between reported profits and sales minus expenses is approximately .80. The results do not qualitatively differ, with returns of 18 percent per month found for capital stock below \$200, and dropping at higher levels of capital.

Finally, the survey also contains a question regarding the firm's accounting system. Entrepreneurs are asked if they employ an outside accountant, use income and expenditure forms provided by the Mexican Treasury, or keep personal records. Larger firms are more likely to invest in the cost of maintaining these accounts, and we lose a substantial percentage of small firms if we restrict our analysis to only firms with formal accounting systems. However, the last row of Table 4 shows that our basic result continues to hold even under this restriction. The level of semi-parametric returns is modestly lower for the \$0-200 range but one still finds returns of 12 percent per month for low capital returns, and lower returns with higher capital stock.[27] Overall, Table 4 suggests mis-measurement of profits or capital is not driving the pattern of returns observed.

4.2. Evidence on Reinvestment Rates:

If the rates of return to capital are as high as those we have estimated, then we should expect entrepreneurs to increase investment levels as capital becomes available. Since the ENAMIN survey gathers capital investment data only once for each enterprise, we are unable to observe reinvestment rates directly. However, more rapid investment should be associated with more rapid growth in income. We do have panel data on income and so are able to examine indirect evidence of rapid growth of low-capital firms by calculating the rate of income growth in the quarters following the ENAMIN survey.

Panel data on income for individual entrepreneurs is available from the quarterly labor survey (ENEU) for as many as 4 quarters following the ENAMIN survey. About 80% of the ENAMIN sample remains in the ENEU survey for at least one quarter after the ENAMIN. Income data is available for these individuals for the ENAMIN quarter and the following quarter.[28] Income data is available for each of the 2 quarters following the ENAMIN for 60% of the sample, for 3 quarters for 40% of the sample and for 4 quarters for 20% of the sample. These data allow us to trace individuals, thus controlling for individual abilities which might be imperfectly measured in the regressions. The estimated returns to capital are highest among firms with invested capital of less than $200 and lower for those with more invested capital. To the extent that higher rates of return elicit more rapid investment of capital, we should observe that the incomes of owners of enterprises with low levels of investment grow more rapidly than the incomes of owners of firms with higher levels of capital investment.

Table 5 summarizes the growth rate of income of those in the ENAMIN survey, grouped by level of capital investment. [29] Because we are interested in evidence of reinvestment of capital, we focus on those individuals who remained in self employment.[30] Note that since wage rates declined rapidly in Mexico between 1994 and 1997, incomes of those in the ENAMIN survey shrink slightly in aggregate in the quarters following the survey. On average, incomes did not change among the 4978 owners for whom we have data one quarter out. The next columns of the first row shows the growth in average income 2 quarters out (-1.2%), three quarters out (0.6%) and four quarters out (-3.9%). The average of these values, weighted by the number of observations, is –0.6%. Owners with less than $200 invested fared better. They saw incomes grow very slightly—by a weighted average of 0.1%. Incomes of those with between $200 and $1000 invested shrank slightly, falling 0.3%, while incomes of those with more than $1000 invested fell by 1.1%. Thus, the incomes of individuals with less than $200 invested grew 1.2% faster than the incomes of those with more than $1000 invested in the quarters after the ENAMIN. However, looking at the standard errors in these mean growth rates, we see that the differences in growth rates across firm sizes are not significant due to the high variance in incomes over one quarter, and shrinking sample sizes as we look over more quarters. Nevertheless, the point estimates are at least in the direction we expect, and are consistent with the higher returns calculated for enterprises with very low levels of invested capital.

5. Explaining the high rates of return

Our best estimate is that return to capital is in the range of 15% per month for investment levels below $200, falling to 3-5% for investment above $500. How do these returns compare with the cost of capital in Mexico? Since only 0.3% of the firms in our sample obtained start-up financing from the formal financial sector and only 0.8% asked for and received their last loan from the formal financial sector, the relevant rates are those associated with informal sources of finance. Mansell Carstens (1995) describes a wide variety of less formal sources of finance in Mexico, including loans from family and friends, microfinance organizations, pawnshops and professional moneylenders.

Compartamos, the largest microfinance company in Mexico, provides small loans to the self-employed poor at interest rates of 3% per month.[31] In 2000 their average loan was $206 while in 2001 the range of first loans was $97-271.[32] Other microfinance organizations offer loans at rates of 3-7% per month, but access to these loans, while increasing, has been fairly limited.[33] The national pawnshop chain *Nacional Monte de Piedad* gives loans worth one-fifth to one-third of an item's value at monthly interest rates which have ranged from 5.5% in 1994, 6% in 1995, 3.75% in 1997, to 3% in 1998.[34] Mansell Carstens (1995) reports similar rates at the other legal pawnshop, *Montepío Luz Saviñón*, and indicates that the majority of loans in 1991 at these pawnshops were less than $170. The limited number of branches and service hours, coupled with the need for assets to pawn, limits this option for many poor self-employed. Informal pawnshops and professional moneylenders (*agiotistas*) offer rates from 10-15% a month up to 15% a week and even 20% per day[35] to those unable to obtain finance from other sources.

The 3-5% monthly returns to capital we find for marginal investments above $500 accord well with the rates offered at the legal pawnshops and at microfinance organizations. The significantly higher returns we find for investments below $200 are more surprising. What explains these returns? Given the nature of our data, we are only able to speculate about the answer to this question. In this section, we explore three possible explanations for the high rates of return. The first is that the high returns represent constraints on capital. The second is that they are the result of a process by which entrepreneurs learn both about their own abilities and the profitability of investments. Finally we examine whether the high returns to low capital entrepreneurs are simply compensating them for higher risk.

The most obvious explanation is that the high returns represent the effects of constraints on access to capital. Those with low levels of investment may want to invest, but are unable to do so. We find some evidence supporting this view. The data clearly indicate that those with the lowest levels of investment come from lower wealth households. The quarterly labor survey (ENEU) contains limited asset information. We know the types of materials used to construct the house in which the entrepreneur lives, whether the house is rented or owned, how many rooms the house has, and whether the household has telephone, electric, and other services. Table 6 shows how certain household characteristics vary by the level of investment in the enterprise. Entrepreneurs investing less than $200 are much more likely to come from households without telephones, households without a separate kitchen, and households with dirt or cement floors (as opposed to wood floors). For example, 21% of the entrepreneurs investing less than $200 come from a household with a telephone, compared with 51% of entrepreneurs investing between $1000 and $5000. Only 36% have a wood floor in their house, compared to 63% of those in the highest investment category.[36] Access to start-up formal credit also varies with assets: households with a phone are five times more likely to have received start-up finance from a bank than households without a phone, and no household with a dirt floor received a bank loan to start their business compared to 2.1% of households with wood floors.

Thus, the housing stock data support the idea that those with the lowest capital investments are those from low-wealth households. We would expect this group to be the most severely capital constrained. Their lack of collateral and the limited access to microfinance prevents them from accessing loans at the 3-5% interest rates, and instead the relevant borrowing interest rate for this group is more likely to be the extremely high rates offered by moneylenders.[37]

A second explanation for high returns at low capital levels involves learning. As in the model of Jovanovic (1982), it may be that entrepreneurs take time to learn their own abilities and the profitability of investments. Entrepreneurs may start by investing small amounts, adjusting their investment levels upward as they learn about the profitability of investments. If this were a primary factor driving the returns to capital, we would expect the group of entrepreneurs in the low capital range to be disproportionately new entrants. We find instead that higher capital firms have a larger proportion of newly established firms. Table 6 shows the percentage of firms by capital investment level which were established within 3 years of the survey, and the percentage established more than 10 years prior to the survey. Among those investing less than \$200, fully 40% had operated for 10 years or more at the time of the survey. Only a third had operated for 3 years or less. Among firms with more than \$1000 invested, the percentages are almost exactly the reverse—39% had been in business less than 3 years and 30% had been in business more than 10 years.[38]

An additional possible explanation is that the high returns to low levels of capital act as compensation for much higher levels of risk associated with low capital projects. Table 6 shows that the exit rates among entrepreneurs with \$0-200 of capital are fifty percent higher than those with more than \$500 of capital. However, the earnings from self-employment are, if anything, less risky for entrepreneurs with low levels of capital. To see this, we use the ENEU panel data to follow the earnings of individuals over several quarters, both for those entrepreneurs who remain in business and for those who exit. The first few columns of Table 7 show the cross-sectional variation in earnings in the first and second quarters following the ENAMIN survey. The coefficient of variation in earnings across individuals is lower for low-capital entrepreneurs than for higher-capital entrepreneurs in both periods. We then consider the variation in earnings over time for each individual, and report the median and mean of the individual coefficients of variation according to the initial level of capital stock. Individuals with capital stock of \$0-\$200 had lower earnings risk over subsequent quarters than did individuals with higher levels of capital stock. In sum, low-capital entrepreneurs do not have greater earnings risk than high-capital entrepreneurs, and so this can not serve as an explanation for the high returns to low levels of capital.

6. Conclusion

Using semiparametric smoothing techniques, we find extremely high returns—on the order of 15% per month-- among firms with invested capital levels below about $200. For investment levels above $1000, however, we find returns to marginal investments of around 3% per month, close to the cost of capital from pawnshop and microcredit programs. Together with evidence on entry costs, the data suggest the absence of barriers to entry in self employment.

Given the high rates of return found at low capital levels, we should expect to find self-employed poor individuals re-investing heavily in their businesses. We do find indirect evidence of this, in the faster income growth for such individuals. The high returns to capital at low levels of investment suggest that modest increases in savings rates among the self employed might lead to rapid growth in incomes. The overall savings rates in Mexico are low in comparison to the East Asian countries, where high savings helped fuel rapid business growth over the last three decades. Mexican microenterprise owners may not be in a poverty trap, but the challenge remains to raise savings rates to take advantage of the returns available in microenterprises. Increased provision of microcredit to such firms would also be most beneficial.

Thus, we find no evidence of non-convex production technologies at low levels of capital investment. This is not to say that credit constraints are not binding for small scale entrepreneurs. Indeed, our evidence is consistent with the presence of severe capital constraints. But credit constraints themselves do not imply a poverty trap. In the absence of non-convexities, entrepreneurs are able to bootstrap their way up over time by steadily reinvesting their profits. Hence, the long run distribution of firm sizes is not impacted by credit constraints in the absence of non-convexities. Our data suggest that entry costs are not likely to affect the long run distribution of firm sizes among the firms represented by our sample.

Although we do not find non-convexities at low levels of capital, the data do suggest the possibility they may be present at higher capital stock levels. The majority of firms in our surveys are informal and employ no workers. A poverty trap may still arise if nonconvexities arise at higher capital levels when firms begin to hire workers and enter the formal sector. Moreover, poverty traps may arise from other sources, such as decisions related to investment in human capital. The policy implications of poverty traps depend critically on the factor leading to the trap. The evidence we have presented suggests that policies designed to alleviate poverty traps which focus solely on alleviating constraints to investment in physical capital are not likely to be effective. Further empirical research on poverty traps should therefore examine slightly larger firms and help address the question as to whether non-convexities are important in determining whether small firms grow, or on other potential sources of poverty traps.

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Appendix A

Mexico's National Statistical Institute (INEGI) conducted the Encuesta Nacional de Micronegocios (ENAMIN) four times during the 1990s. The first survey was carried during the 1st calendar quarter of 1992, the second and third during the first calendar quarter of 1996 and 1998, respectively, and the last during the fourth calendar quarter of 1998. In each case, the sample for the ENAMIN was drawn from those individuals surveyed in the quarterly urban labor survey (ENEU) who reported working as self employed workers. In 1992, the survey was drawn from the 4th quarter 1991 ENEU sample. In the other years, the ENAMIN sample was drawn from the ENEU sample of the same calendar quarter. The survey instrument was modified somewhat in 1994 and again in 1998. With one exception, we are able to construct comparable variables for all years. The 1992 survey does not collect the same information on the cost of business premises as the other surveys, and so for 1992 we only use data for firms without specific business premises.

The ENEU is a quarterly rotating panel, so that once selected, households remain in the ENEU survey for five quarters. We are also able to match the ENAMIN data with the ENEU data for the same household. Thus, we are able to track owners of the enterprises for as many as five calendar quarters. The enterprise data contained in the ENAMIN—investment levels, number of employees, and so on—is available for only one quarter for each enterprise surveyed. But by matching the ENAMIN survey back to the ENEU survey, we are able to obtain labor market and income data on some individuals for several quarters leading up to the ENAMIN survey and on some individuals for several quarters following the ENAMIN survey.

Description of Variables

All variables are taken from the ENAMIN surveys unless noted otherwise.

Capital stock is the sum of the reported replacement cost of all owned or borrowed physical capital and the market price of all firm inventories. Physical capital is the sum of the owner's separate responses for the replacement value of tools, machinery, furniture, vehicles, premises, and other business equipment.

Monthly earnings of the self-employed are the reported answer to the question "how much do you obtain as earnings after deducting expenses?".

Owner's labor hours are a normal week's hours dedicated to attending to clients, preparing items to sell, buying materials, visiting clients, making repairs, and carrying out business transactions.

Firm age is the number of years since the owner began the activity or founded the business (92% of the sample), or since the owner became head of the business if someone else founded it. The median firm age for firms with less than $5000 capital stock is 5 years.

Mean log hourly wage in State-industry-year is taken from the ENEU survey taken at the same time as the ENAMIN and is the mean log hourly wage of wage workers by state and industry interacted.

Owner's age, education and marital status, and total paid and unpaid workers' hours are self-explanatory.

Endnotes

[1] Banerjee (2003) provides an excellent recent survey.

[2] Mookherjee and Ray (2002) show that poverty traps can arise even with convex production technologies. They develop a model with moral hazard in which principals are matched with agents each period. When principals have all of the bargaining power in the relationship, they must provide agents without any wealth rents in order to induce effort. An agent's wealth acts as collateral for promised effort levels, removing the need for rents. Since wealth accumulation by agents is effectively taxed in this manner, return to wealth accumulation is low.

[3] Extension of the methods of this paper to larger firms could also help shed light on the phenomenon of a "missing middle" in the size distribution of firms in developing countries, which is sometimes attributed to the presence of bureaucratic obstacles once firms reach a certain size (Tybout, 2000).

[4] Furthermore, as we have discussed, employment growth is likely to only be weakly related to marginal returns to capital in very small firms due to the lump-sum costs involved in hiring another worker.

[5] We focus on males because they are generally seen to have a stronger labor force attachment. However, data for females show patterns similar to those described here for males, including the pattern of returns to capital.

[6] The data are first translated to 1998 pesos using the GDP deflator and then translated to dollars so that the volatility of the peso/dollar exchange rate does not affect the data.

[7] For this reason several previous studies have used employment as their measure of firm size (e.g. Biggs and Srivastava 1996, Liedholm and Mead 1999). Such an approach is clearly not possible here, since many of the small firms have no employees and our interest lies in the shape of their production technology.

[8] We ignore interest on savings in constructing these estimates, which may be reasonable given Mexico's underdeveloped financial system.

[9] The direct costs of inventories and leasing premises are included in the physical capital amounts in Panel A.

[10] We exclude equipment and real estate which is rented rather than owned, since a significant portion of the return to this capital is the rental price which is not included in the firm's profits. Most business capital

is owned; rented capital averages 4.3 percent of total capital for firms with below $200 of capital stock and 14.7 percent for firms with $1000-5000. Inventories average 8 percent of the value of capital stock for firms with capital stock below $200 and 10 percent of capital for capital stock between $1000 and $5000.

[11] When we estimate returns separately by year we find similar returns each year, and so combine years in order to increase the sample size available.

[12] Above $5000, the density of observations falls, making reliable estimates more difficult to obtain.

[13] For the parametric estimation, we add roughly the next 20% of observations beyond the capital stock cutoff of interest in order to mitigate boundary effects. Results from parametric estimation can be sensitive to the interval over which the global polynomial in capital is estimated. We use enterprises with up to $1400 in capital to estimate returns in the $0-$1000 range, and up to $6000 for the $500-$5000 range.

[14] The absolute magnitudes of these effects are however much lower when the state-industry wage variable is included in the regression, suggesting that this variable captures a large portion of the year and industry effects.

[15] The six industries chosen were those with most observations available for estimation.

[16] In construction, the 80th percentile of capital stock is only $390. The parametric and local linear returns differ most for this industry, but both find monthly returns above 10 percent for capital stock below $300. The fact that we do not observe many construction firms with capital stock above $500 prevents us from estimating the returns to capital at higher levels for this industry.

[17] We do not have panel data on the firm side, preventing the methods of Levinsohn and Petrin (2003) from being used to measure productivity. Moreover, the size of our firms and the lack of inventories or electricity expenditure for many of them would prevent straight-forward application of Levinsohn and Petrin even with a panel.

[18] Among the large firms examined in the credit constraints literature just referenced, the market for managerial talent ensures some degree of homogeneity in the ability of the firms' top management. Essentially all of the small firms in our sample, however, are owner-managed. Hence, unmeasured differences in the ability of entrepreneurs are likely to be more prevalent in our sample.

[19] If ω_i is correlated with elements of X_i, its exclusion will also result in a bias in the coefficients of those variables.

[20] The decision to enter self employment should be based on ability in self employment *relative* to ability in wage work. The wage residual instead provides a measure of absolute entrepreneurial ability. Think of ability (θ) as being made up of three parts: $\theta = \theta_g + \theta_w + \theta_e$, where θ_g is a vector of characteristics measuring general ability, useful in both wage work and self employment (e.g., innate intelligence), θ_w is a vector of abilities useful only in wage employment (e.g., the ability to follow directions), and θ_e a vector of abilities useful only in self employment (e.g. market savvy). Then the decision to enter self employment will depend on how θ_w compares to θ_e , but earnings from self employment will depend on θ_g and θ_e, and the wage residual will depend on θ_g and θ_w. As long as θ_g is large relative to the other two components, the wage residual will provide a measure of ability as an entrepreneur as well.

[21] A t-test could not reject that these two reasons had equal effects on earnings.

[22] The parametric returns are not shown on Table 3 in the interest of space. The parametric results are very similar to the semi parametric results, both in the significance of the measures of ability and in the lack of an effect on the marginal returns to capital.

[23] The sample is limited to enterprises operating with less than $500 in capital, because that is where we find the highest returns and because that is where we the data are dense enough to produce reliable estimates.

[24] Or less than $1400 for the parametric estimation.

[25] The semi-parametric returns do not change at higher levels of capital as they only use local observations for estimation, and hence are by construction robust to any change over the lower capital range.

[26] As with the original measure of profits, we drop the top and bottom 1 percent of reported profits as outliers.

[27] The reduction in sample size means that the semi-parametric, local linear regressions make use of more data from firms with higher capital stocks. This explains at least part of the lower returns to capital shown in the last row of Table 4.

[28] Panel data on consumption is not available for Mexico, preventing us from examining implications of our returns for consumption and saving behavior among the self-employed.

[29] The income data is very noisy, so the top and bottom 1% of incomes are discarded for the ENAMIN quarter and each of the 4 quarters following before the average income levels are calculated. The results are not changed much by this truncation.

[30] Exit rates in the $0-200 category are somewhat higher than in the $1000-$5000 category. For example, 75% of those with $0-$200 in capital for whom we have data remain self employed four quarters later, while 84% of those in the $1000-$5000 range do so. Those who exit have, on average, similar earnings to those who remain self employed, so we do not believe these exit rates explain the differences in income growth rates among those who remain self employed.

[31] See "Micro-loans help entrepreneurs", Business, Pg. 1, *The Houston Chronicle*, August 12, 2000.

[32] Source: Accion International 2001 Annual Report, available at http://www.accion.org/PDF/2001ar.pdf

[33] Source: Conversation with Marc de Sousa-Shields, Enterprising Solutions Global Consulting, 29 July 2002.

[34] Sources: "Nacional Monte de Piedad, consolidado como institucion de asistencia; cobra tasa de 3%", *El Nacional*, March 13, 1998; "Bank of the poor", *The Boston Globe*, June 15, 1995; "Frentes Politicos", *El Excelsior*, January 7, 1997; "Mexico's poor make do without national pawnshop", *The Ottawa Citizen*, January 15, 1998.

[35] Sources: Mansell Carstens (1995, pp. 94-100); "It only takes a small loan to fight Mexico's poverty", *The Houston Chronicle*, October 13, 2001.

[36] The remainder have cement or dirt floors.

[37] Loans from friends and family are also important, but tend to be for periods of one month or less, for amounts averaging no more than 100-200 pesos ($30-$60) in 1992 (Mansell Carstens, 1995, p. 77).

[38] This could reflect the fact that older firms have older, and more fully depreciated equipment. A similar investment might have a lower replacement cost among older firms. However, we find a similar pattern when we look at the distribution of firm age by investment in inventories among those firms involved in trade. Since inventories are continuously replenished, differences in depreciation should not affect these data.

TABLE 1: NON-CONVEXITIES UPON ENTRY

Characteristics of Firms 2 or less years old

PANEL A: START-UP CAPITAL STOCK

		Percentiles of Total Owned Capital Stock (1998 Q4 US$)					% of firms reporting no initial funds needed	Months of earnings capital stock represents: 10th earnings percentile[1] capital stock decile		median earnings[1] capital stock decile	
Industry Category	*# Obs.*	*10th*	*25th*	*median*	*75th*	*90th*		*10th*	*25th*	*10th*	*25th*
construction	246	22.8	46.8	99	211	937	23.8	0.2	0.4	0.1	0.2
manufacturing	525	107.7	280.5	882	3509	11594	6.8	1.0	2.6	0.5	1.4
miscellaneous services	42	67.3	643.7	4449	14835	18950	3.9	0.6	6.0	0.3	3.2
personal services	202	3.1	7.8	42	279	2950	47.0	0.0	0.1	0.0	0.0
professional services	224	126.7	534.3	3155	6858	13935	17.8	1.2	5.0	0.6	2.7
repair services	729	34.3	91.8	277	1452	3683	12.9	0.3	0.9	0.2	0.5
restaurants & hotels	267	97.7	205.6	557	1940	5160	0.7	0.9	1.9	0.5	1.0
retail & wholesale trade	1079	70.7	328.5	1892	4809	11983	3.0	0.7	3.1	0.4	1.6
transportation services	370	814.9	2070.0	4498	9727	16999	3.0	7.6	19.3	4.1	10.4
ALL INDUSTRIES	3684	42.1	147.8	963	3813	9893	10.1	0.4	1.4	0.2	0.7

PANEL B: OTHER START-UP COSTS

	Percentage of Firms with					
	No paid workers	No formal premises	No inventories	No treasury registration[2]	No other registration[3]	None of
Industry Category	(a)	(b)	(c)	(d)	(e)	(a) - (e)
construction	79.3	98.5	96.5	93.1	96.2	73.2
manufacturing	72.6	61.6	52.4	63.8	78.3	26.1
miscellaneous services	70.6	43.1	59.2	45.1	51.0	21.6
personal services	93.9	85.9	84.2	86.6	79.0	61.5
professional services	74.9	46.2	79.6	26.2	66.9	14.9
repair services	82.7	68.1	77.3	70.5	88.8	46.3
restaurants & hotels	77.0	63.3	56.2	65.7	48.3	19.7
retail & wholesale trade	86.0	59.2	25.0	54.1	61.6	14.8
transportation services	84.4	97.7	95.0	44.0	27.6	12.1
ALL INDUSTRIES	81.9	68.0	59.4	60.8	68.2	28.8

Notes:

Results are for firms in existence for 2 years or less with male owners aged 18-65 years who work 35 hours or more a week

source: authors' calculations from 1992, 1994, 1996 and 1998 ENAMIN surveys

1. Earnings percentiles are for male wage-workers aged 18-65 who work 35 hours or more a week (calculated from 1998 ENEU Q4).
2. Firm is not registered with the Secretaria de Hacienda
3. Firm is not registered with trade or business organization, chamber of commerce, state treasury, health secretary, SECOFI (Mexican Ministry of Commerce and Industrial Development) or SIEM (Mexican Business Information System).

TABLE 2: PARAMETRIC AND SEMI-PARAMETRIC RETURNS REGRESSIONS

Dependent Variable: Monthly earnings (in 1998 Q4 US$)

	LOW CAPITAL				HIGH CAPITAL			
	Parametric ($0-$1400 capital)		Semi-parametric ($0-1000 capital)		Parametric ($500-$6000 capital)		Semi-parametric ($500-$5000 capital)	
Non-capital Variables:	Model i	Model ii	Model i	Model ii	Model i	Model ii	Model i	Model ii
Owner's Labor hours	0.265	0.271	0.356	0.353	0.290	0.263	0.325	0.323
	(0.151)	(0.150)	(0.163)	(0.162)	(0.276)	(0.281)	(0.294)	(0.298)
Owner's age	1.166	1.423	1.704	1.732	-2.209	-1.713	-1.850	-1.457
	(1.026)	(1.004)	(1.074)	(1.054)	(2.534)	(2.506)	(2.667)	(2.635)
Owner's age squared	-0.029	-0.030	-0.033	-0.032	0.001	-0.005	-0.004	-0.009
	(0.012)	(0.012)	(0.013)	(0.013)	(0.030)	(0.030)	(0.032)	(0.031)
Owner has primary education[1]	10.574	14.125	13.477	16.379	3.844	10.782	9.488	16.869
	(4.210)	(4.129)	(4.378)	(4.314)	(11.443)	(11.323)	(12.051)	(11.914)
Owner has junior high	12.366	19.739	15.557	21.314	6.910	13.769	1.755	8.187
	(4.841)	(4.766)	(5.097)	(5.038)	(11.936)	(11.839)	(12.488)	(12.364)
Owner has high school	14.347	25.207	19.018	28.515	38.531	45.807	43.764	50.410
	(6.554)	(6.455)	(6.989)	(6.910)	(13.442)	(13.367)	(14.135)	(14.037)
Owner has college education	70.421	97.556	70.702	92.006	109.203	124.463	103.734	119.033
	(7.724)	(8.782)	(8.719)	(9.934)	(13.280)	(14.977)	(14.066)	(15.904)
Married Owner dummy	22.275	20.746	22.417	20.738	34.030	30.491	34.550	29.629
	(4.568)	(4.467)	(4.783)	(4.696)	(11.724)	(11.627)	(12.439)	(12.314)
Age of Firm	2.479	1.898	2.635	2.044	4.929	5.165	4.132	4.443
	(0.526)	(0.517)	(0.550)	(0.544)	(1.313)	(1.307)	(1.378)	(1.369)
Age of Firm Squared	-0.041	-0.026	-0.047	-0.032	-0.096	-0.094	-0.080	-0.077
	(0.015)	(0.015)	(0.016)	(0.016)	(0.041)	(0.041)	(0.043)	(0.042)
Total unpaid workers' hours	0.222	0.355	0.201	0.321	0.391	0.169	0.401	0.162
	(0.102)	(0.102)	(0.111)	(0.111)	(0.169)	(0.174)	(0.181)	(0.185)
Total paid workers' hours	0.952	0.921	0.915	0.873	1.188	1.214	1.182	1.200
	(0.065)	(0.064)	(0.072)	(0.072)	(0.088)	(0.090)	(0.097)	(0.098)
Mean log hourly wage in State-industry-Year	166.44	155.00	150.39	154.84	203.35	247.39	180.288	221.774
	(5.637)	(9.444)	(6.477)	(10.149)	(12.879)	(20.377)	(13.809)	(21.534)
constant	142.23	147.28			328.06	311.47		
	(21.228)	(21.496)			(85.325)	(86.530)		
Year effects	no	yes	no	yes	no	yes	no	yes
Industry effects	no	yes	no	yes	no	yes	no	yes
#observations	7344	7344	6641	6641	5076	5076	4642	4642
Adjusted R-squared	0.205	0.244			0.142	0.164		

Notes:

Results are for firms with male owners aged 18-65 years who work 35 hours or more a week. Data is trimmed by eliminating the top and bottom one percent of reported dollar profts and observations with reported own labor hours above 99.

The parametric model contains a fifth-order polynomial in non-rented capital stock.

Standard errors are given in parentheses. Semi-parametric estimation and standard errors are from fifth-order higher order differencing using the optimal differencing weights given in Yatchew (1998, p. 697).

1. Omitted Education category is no schooling

TABLE 3: CONTROLLING FOR OWNER ABILITY

Results from adding additional regressors to model ii in Table 2.

Dependent Variable: Monthly earnings (in 1998 Q4 US$)

	Model A		Model B		Model C		Model D	
	S base	S	S-base	S	S-base	S	S-base	S
Additional Regressors								
Spouse has primary education[1]		6.792				4.481		
		(4.779)				(10.497)		
Spouse has junior high education		18.360				-11.956		
		(6.024)				(13.691)		
Spouse has high school education		13.897				-26.615		
		(7.354)				(17.439)		
Spouse has college education		24.606				34.334		
		(12.683)				(30.844)		
Average wage premium prior to entry				0.122		0.109		
				(0.027)		(0.030)		
Entered business to increase income or								24.982
due to family tradition[2]								(4.433)
Entered business as couldn't find work or was								-5.641
laid off from job								(5.140)
#observations	4947	4947	1040	1040	724	724	5254	5254
Adjusted R-squared								
Median of estimated returns								
Capital Stock $0-200	16.2	15.8	15.6	14.9	16.1	16.0	24.3	22.9
Capital Stock $200-500	6.3	6.0	10.8	9.5	15.3	13.9	4.2	3.9
Capital Stock $500-1000	5.3	5.2					6.8	7.0
Capital Stock $1000-2000	2.3	2.5					2.9	2.7
Capital Stock $2000-5000	2.4	2.3					2.6	2.7

Notes:

Other regressors include the owner's labor hours, age and age squared, owner's education, age of the firm and age of the firm squared, total paid and unpaid labor hours, the mean log hourly wage in the state and industry and year and industry effects.

In models b and c the parametric model is estimated over capital stock $0-800 and the semi-parametric for capital stock $0-500 due to sparse observations at higher capital levels. Coefficients models a and d are reported for $0-1400 (P) and $0-1000 (S), however these models were also estimated separately over higher capital stock levels to obtain returns for capital stock above $1000.

Standard errors are given in parentheses. Semi-parametric estimation and standard errors are from fifth-order higher order differencing using the optimal differencing weights given in Yatchew (1998, p. 697).

1. Omitted Spouse education category is no schooling

2. Omitted category is beginning business to supplement family income or in order to have flexible hours

TABLE 4: ROBUSTNESS OF RETURNS TO MEASUREMENT ISSUES

	Semi-parametric Median Returns by capital stock range				*Parametric Median Returns by capital stock range*			
	0-200	200-400	400-600	600-1000	0-200	200-400	400-600	600-1000
Model ii	22.6	6.5	5.4	4.7	22.1	10.7	6.8	1.6
Robustness to low capital stock								
dropping bottom 5% of capital	24.1	6.5	5.3	4.8	27.0	9.4	6.6	2.8
dropping bottom 10% of capital	23.1	6.4	5.3	4.8	22.3	10.0	6.8	2.2
dropping bottom 25% of capital	14.1	6.4	5.4	4.9	22.4	9.7	6.6	2.7
Robustness to profit measure								
Profits = Revenues - Expenses	18.0	8.4	7.2	6.6	20.5	9.5	9.4	3.6
Robustness to Accounting System								
Sample that uses an accounting syst	11.7	8.5	6.3	3.9	18.2	9.9	4.6	2.1

Notes:
Cubic in Capital Stock used in place of fifth-order polynomial for sample with accounting system due to small sample size.

Table 5: INCOME GROWTH FOLLOWING ENAMIN SURVEY QUARTER
Among workers remaining self employed

	Income Growth					Average weighted by # of observations
	1Q after	2Q after	3Q after	4Q after	Average	
Self employed, < $5000 invested	0.0%	-1.2%	0.6%	-3.9%	-1.1%	**-0.6%**
(# observations)	5349	3882	2487	986		
Self employed, <$200	0.4%	-0.4%	1.6%	-3.8%	-0.6%	**0.1%**
Standard errors	*1.7%*	*2.1%*	*2.4%*	*4.1%*		
(# observations)	*1906*	*1355*	*884*	*337*		
Self employed, $200-1000	-0.7%	0.8%	-0.5%	-2.4%	-0.7%	**-0.3%**
Standard errors	*2.2%*	*2.5%*	*3.2%*	*4.8%*		
(# observations)	*1486*	*1100*	*720*	*280*		
Self employed, >$1000	0.1%	-2.8%	0.8%	-4.9%	-1.7%	**-1.1%**
Standard errors	*1.9%*	*2.0%*	*2.8%*	*3.9%*		
(# observations)	*1957*	*1427*	*883*	*369*		

Notes:
Sample is limited to those who remain self employed in the quarters following the ENAMIN.
Entrepreneurs in the top 1% or bottom 1% of income in any of the quarters are excluded.

TABLE 6: CHARACTERISTICS OF FIRMS AND OWNERS BY LEVEL OF CAPITAL

Percentage of group with various characteristics

	Owner from household with:			Characteristics of owner:				Firm Characteristics	
Capital stock:	Telephone	Separate Kitchen	Wood Floors	< 6 yrs School	>=12 yrs School	22-35 years old	46-65 years old	Firm <3 years old	Firm 10+ years old
$0-200	21.2%	77.0%	35.7%	42.1%	6.6%	34.9%	33.3%	33.5%	40.0%
$200-500	30.0%	82.4%	45.6%	32.8%	6.4%	35.9%	32.2%	36.5%	35.7%
$500-1000	38.2%	87.6%	52.5%	24.2%	19.4%	37.2%	29.4%	38.0%	34.7%
$1000-5000	50.7%	91.1%	62.5%	18.5%	27.0%	36.5%	30.0%	39.2%	30.4%

TABLE 7 - IS LESS CAPITAL MORE RISKY?

	CROSS-SECTIONAL VARIATION IN EARNINGS						TIME SERIES VARIATION		EXIT
	One quarter after ENAMIN			*Two quarters after ENAMIN*			Median	Mean	RATE
Capital Stock in ENAMIN	Mean income	Std. Dev.	Coefficient of Variation	Mean income	Std. Dev.	Coefficient of Variation	Coefficient of Variation	Coefficient of Variation	
0-200	204	148	0.73	211	146	0.69	0.36	0.43	0.357
200-500	233	180	0.77	254	184	0.72	0.37	0.45	0.282
500-1000	287	221	0.77	296	239	0.81	0.38	0.44	0.247
1000-5000	325	252	0.78	342	257	0.75	0.42	0.48	0.232

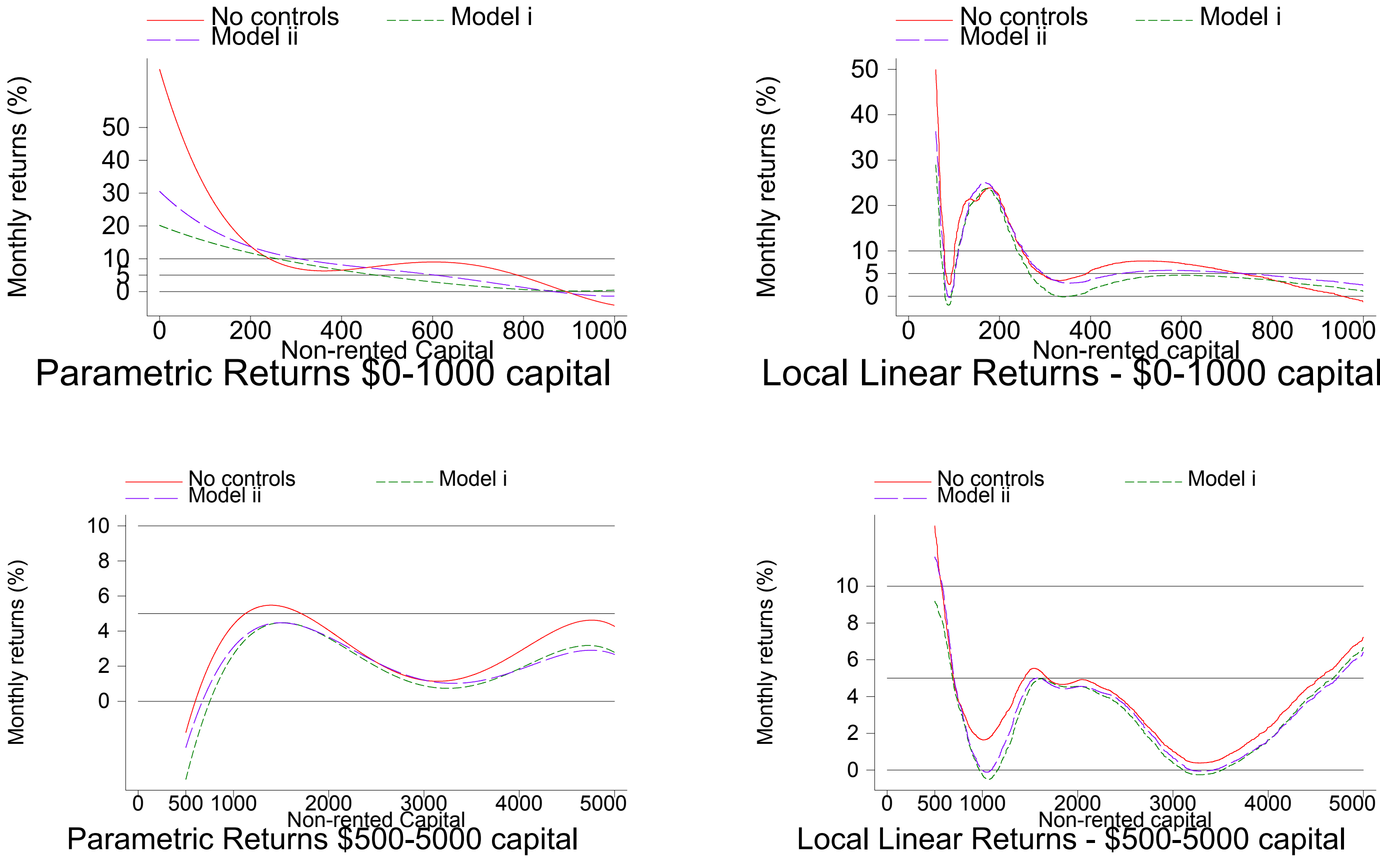
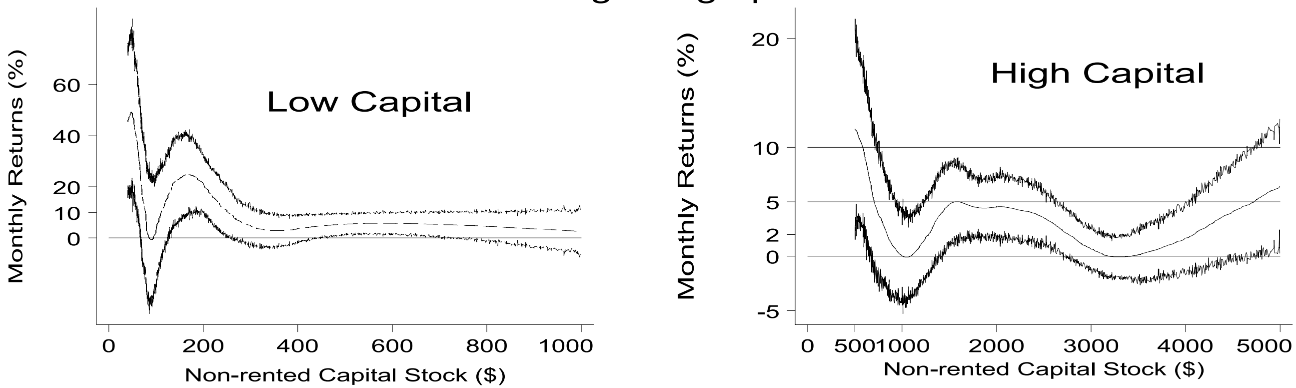


Figure 1: Returns to Capital with controls - All Industries

Figure 2: 95% Bootstrap Confidence Intervals for Returns

2A: Smoothing using optimal bandwidth



2B: Oversmoothing to reduce variance

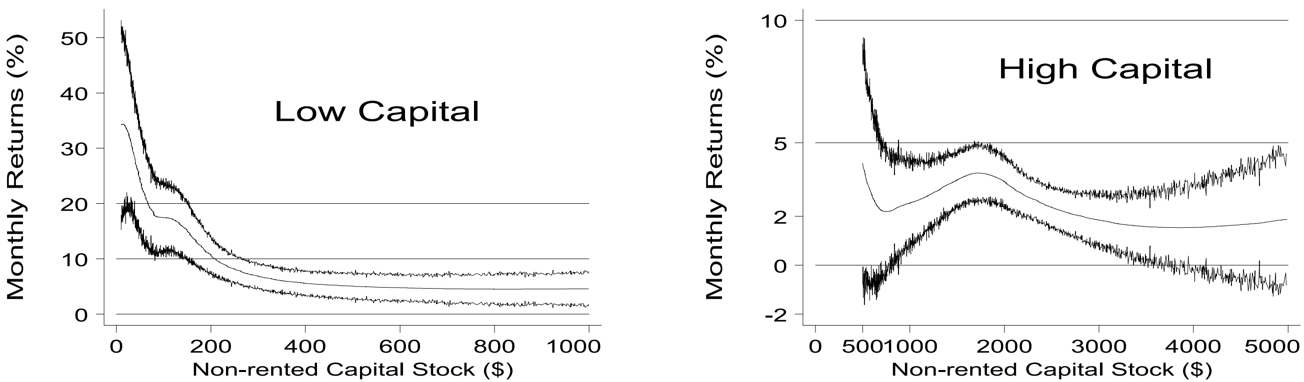


Figure 3: Returns to Capital by Industry