Investment Choice and Inflation Uncertainty

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March 2011

Abstract

This paper investigates the relationship between inflation uncertainty and the investment decisions of small, microfinance-funded firms in the Dominican Republic. An extensive literature documents the array of opposing factors linking inflation uncertainty and investment, but ultimately this relationship is theoretically ambiguous. Using loan-level panel data from microfinance borrowers in the Dominican Republic, I find that periods of increased inflation uncertainty are associated with substantially lower investments in fixed assets and reduced business growth. This finding is robust to specifications controlling for other forms of systemic risk and aggregate economic activity, suggesting inflation uncertainty creates potentially large distortions to the investment decisions of poor entrepreneurs.

Keywords: investment, uncertainty, inflation
JEL Classification Codes: O12, D81, G21, E31

*I would like to thank Esther Duflo, Abhijit Banerjee, Tim Besley, Raymond Guiteras, Rick Hornbeck, Trang Nguyen, Torsten Persson, Tom Wilkening, and seminar participants at Columbia University for many useful comments. The borrower data for this project were developed as part of joint research with Antoinette Schoar and Alejandro Drexler, for which Héber Delgado Medrano provided excellent research assistance. The management of ADOPEM in Santo Domingo, Dominican Republic, in particular Mercedes Canalda de Beras-Goico and Juan Francisco Terrero Silva, was incredibly helpful and patient in providing access to their data and an understanding of their business. I gratefully acknowledge the financial support of the National Science Foundation's Graduate Research Fellowship.

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1 Introduction

The relationship between inflation and economic activity has long been of interest to economists. Attention receded somewhat during the period of generally low and stable inflation in the 1990s and early 2000s; however, with inflation resurging throughout large parts of the world, particularly in less developed countries, and threats of deflation elsewhere, this question has returned to the fore.

Over the years, a large and varied theoretical literature has sought to address this question, considering numerous channels through which uncertainty about inflation could generate real economic effects. Much of this work has focused on the link between inflation uncertainty and investment. Theory has not, however, produced unambiguous predictions about the sign of this relationship.[1] In light of the lack of robust theoretical predictions, a wealth of studies have sought to establish an empirical relationship between inflation uncertainty and investment. At the country level, the preponderance of evidence points to a negative relationship: higher volatility is associated with lower investment.[2] Pindyck and

[1] Friedman (1977) argues that inflation volatility and uncertainty may "render market prices a less-efficient system for coordinating economic activity," thereby reducing allocative efficiency. When nominal rigidities are present, inflation uncertainty generates uncertainty about the relative price of final goods and input costs. Even without nominal rigidities, Lucas (1973) argues, increased inflation uncertainty accentuates firms' real responses to observed price variation and worsens the trade-off between output and inflation. Fischer and Modigliani (1978) systematically catalog a range of channels through which inflation can affect real outcomes, including what they consider to be the focus of "practical men": inflation makes it difficult to plan in the absence of knowledge about future prices. Drawing on option pricing theory, Pindyck (1988, 1991) generalizes this observation to show that uncertainty increases the option value of delaying irreversible investment. Huizinga (1993) draws on this result to build a theoretical link between inflation uncertainty and reduced investment.

Numerous others point to the possibility of a positive relationship. Hartman (1972) and Abel (1983) demonstrate that uncertainty increases investment when adjustment costs are convex and the profit function is convex in prices. Dotsey and Sarte (2000) show that precautionary savings can also produce a positive correlation between inflation variability and investment, while Caballero (1991) shows the relationship between uncertainty and investment depends on industry structure. Some degree of imperfect competition is required for a negative relationship between inflation volatility and investment even in the presence of asymmetric adjustment costs.

[2] Holland (1993) summarizes 18 studies of the empirical link between inflation uncertainty and real activity in the United States; 14 find a negative relationship, three are insignificant, and only one (Coulson and Robins 1985) finds a positive relationship. Ramey and Ramey (1995) demonstrate a strong negative relationship between business cycle volatility and mean growth rates in OECD countries and suggestive evidence in a broader set of 92 countries.

Solimano (1993) and Aghion, Angeletos, Banerjee, and Manova (2010) demonstrate that this negative relationship is particularly strong in less developed countries, where prices also tend to be more volatile. Yet despite this fact and perhaps owing to data limitations, most empirical work in this area has focused on OECD countries. Moreover, these studies tend to focus on country or industry investment aggregates, which poses challenges for identifying the precise channels through which inflation uncertainty reduces investment.[3]

This paper begins to fill these gaps by using a unique panel of administrative loan data from a large, Dominican microfinance institution to evaluate the effect of inflation uncertainty on the investment decisions of small, individual firms. The data show that periods of high inflation volatility are associated with reduced fixed asset investment and firms investing a larger share of loan proceeds in working capital. A one percentage point increase in inflation uncertainty, approximately 1.15 standard deviations, is associated with a reduction in intended fixed asset investment of between 15% and 37% relative to the mean. While inflation uncertainty may serve as a proxy for other forms of systemic risk or macroeconomic factors, the negative relationship between uncertainty and firm-level investment is robust to controlling for inflation levels, exchange rates, and aggregate economic activity. These results support the view that price stability remains an important objective of economic policy and highlight the importance of uncertainty in the investment decisions of poor entrepreneurs.

Note that I do not find evidence for decreased total investment or a reduction in borrowing. Rather, in period of increased uncertainty, borrowers appear to substitute from fixed assets towards working capital. For intuition behind one potential channel for this result, consider the following example. A Dominican microfinance client runs a *colmado* (a small corner store) from which she sells retail goods at a fixed markup over cost. With the pro-

[3] Bloom, Bond, and Van Reenen (2007) is a notable exception. They numerically solve a model of partially irreversible investment for the effects of uncertainty on short-run investment dynamics and test this model on a simulated panel of firm-level data. They then apply the same approach to study the investment behavior of 672 publically traded U.K. manufacturing companies over the period 1972-1991, finding evidence of more cautious investment behavior for firms subject to greater uncertainty, as measured by the volatility of the firms' equity returns.

ceeds from her loan, she considers two investment opportunities: buying more inventory for her store (working capital) or purchasing a refrigerator that will last many years and allow her to expand her product offerings (fixed asset investment). The resale value of the refrigerator is substantially below her cost, i.e., the investment is partially irreversible. When all prices are certain, her optimal choice is clear: make whichever investment generates the highest expected return. But the introduction of uncertainty distorts her choice. With a fixed markup, price volatility in the inventory she purchases is naturally hedged by corresponding changes in the price for which she sells it. In contrast, after paying a fixed price for the refrigerator, the returns to this investment are more sensitive to price volatility. As a consequence, she will demand a higher expected return from the fixed asset investment when prices are uncertain. Even when uncertainty does not affect the expected returns to different investment opportunities and even when borrowers are risk neutral, uncertainty can distort choices towards more flexible factors of production. Risk aversion accentuates this distortion.

Section 2 discusses the theory of inflation uncertainty and investment behavior, extends this example of a borrower's investment choice under uncertainty, and presents a simple two-factor model of investment behavior. The rest of the paper is organized as follows. Section 3 examines the behavior of inflation uncertainty in the Dominican Republic using monthly price data. Using an GARCH model, I calculate the conditional variance of inflation, which will serve as the key measure of inflation uncertainty in the analysis of microfinance borrowers' investment decisions. Section 4 summarizes the source of borrower data, and section 5 describes the empirical strategy for estimating the effect of inflation uncertainty on investment choices and firm growth. Section 6 reports the results of this estimation, and the final section concludes.

2 A Model of Uncertainty and Investment Choice

This section summarizes some of the existing theory of uncertainty and investment, describes an example of a borrower's investment choice under uncertainty, and presents a simple two-factor model of investment behavior. As stated above, theory offers a number of competing perspectives on the issue. We will not resolve them here. Instead, the aim is to frame what is inherently an empirical question and provide a concrete, if stylized, example of how uncertainty can affect a firm's investment decisions.

One strand of the theoretical literature has pointed towards a positive relationship between uncertainty and investment (Abel 1983, Hartman 1972). In both cases, the result proceeds from the realization that if the firm's profit function is convex in prices and capital adjustment costs are convex, a mean-preserving spread of prices increases the optimal level of investment. Caballero (1991) shows how this relationship depends on market structures. When markets are competitive, he shows that investment decisions depend almost entirely on the price of capital and its expected marginal profitability, which, as in Abel and Hartman, is convex with respect to prices. A Jensen's inequality argument shows that the optimal response to uncertainty is to increase investment. In contrast, when competition is imperfect, an increase in investment today makes it more likely that a firm will tomorrow have too much capital relative to its desired level. When adjustment costs are asymmetric (i.e., net of direct costs, it is more costly to reduce capital than to increase it) having too much capital is worse than having too little. Here, the uncertainty-investment relationship can turn negative.

Zeira (1990) notes that the fixed discount rate assumption of other studies is tantamount to risk-neutrality. He builds a model of investment that incorporates shareholder risk aversion and demonstrates that the uncertainty-investment relationship becomes indeterminate in this framework.

Pindyck (1991) looks at the case of irreversible investments (i.e., largely sunk costs that cannot be recovered), focusing on those for which delay is possible and allows the firm to gather new information about prices and other market conditions before making the investment. While firms do not always have the opportunity to delay investments—they may, for example, be subject to a short-lived strategic window—he argues that in most cases delay is feasible. In such case, the standard rule of investment decisions, which says that a firm should invest in a project when the present value of its expected net cash flows exceeds its cost, is no longer optimal. When investments are irreversible and decisions to invest can be postponed, increased uncertainty makes firms more reluctant to invest.

The reasoning behind this argument is instructive and builds on an analogy between real and financial investment decisions. The opportunity to make a real investment is like a call option on the underlying capital. Making the investment is like exercising the option with the cost of the investment the strike price of the option. Standard techniques of financial asset valuation tell us how to price the option and when to exercise it optimally.

2.1 A Stylized Example of an Investment Decision

Consider the following example, similar to ones used in Pindyck (1991) and Huizinga (1993). Suppose a small, credit-constrained business with a discount rate of 2% per month has access to an 8,000 peso loan. It can allocate the proceeds from this loan either to working capital (short-term assets such as inventory for a store) or to a long-term asset (e.g., a refrigerator that would allow the store to expand its product offerings). Assume short-term assets just break even, returning 2% (plus the entire original investment) after one month, and this amount can be reinvested in either asset each month.

First, consider a certain environment where the incremental profits from the long-term asset are 200 pesos per month in perpetuity. With certain investment returns, the firm's investment decision is straightforward and can be derived from the standard net present value calculation. The NPV of the long-term investment is 2,000 pesos, while the NPV of the short-term investment (assuming the firm reinvests in short-term assets every month) is 0.

Now consider the case of uncertainty of a very simple form: after one month, the firm will discover whether the monthly incremental profits from the long-term investment are 300 or 100. Each state occurs with equal probability, so that the expected profits remain the same as in the certain case, 200 pesos per month. For simplicity, assume that regardless of whether or not the business makes the investment, this uncertainty is resolved after one month and that once realized, profits will remain at this level forever.[4] If the firm is risk neutral, the net present value calculations are the same: 2,000 pesos for the long-term investment and 0 for the short-term investment. However, the borrower should not make the long-term investment now.

In the state of the world when profits are low, the business would have preferred not to make the long-term investment. The standard net present value calculations do not incorporate the possibility of waiting and preserving the option not to invest should profits obtain the lower value. Instead of investing today, the entrepreneur should wait one month until the uncertainty is resolved and invest only if profits attain the higher level. Table 1 presents these calculations.

The key insight here is that even for risk neutral businesses and positive NPV projects, firms should only invest today if the cost of delay exceeds the option value of waiting until uncertainty is resolved. Analogous to financial option theory, greater uncertainty increases the value of waiting, thus requiring a higher incremental profit for the firm to optimally invest today.

This effect is potentially quite economically significant. Continuing with the stylized example from above, in the absence of uncertainty, the long-term asset need only match the return of the short-term asset (26.8% per year or 160 pesos per month) in order for the firm

[4] Dixit (1989) extends the analysis to cases where uncertainty is resolved over time. For our purposes, there is no substantive difference.

to invest today. In contrast, suppose revenues are uncertain such that prices either rise or fall by 1%—roughly the median monthly standard deviation of inflation in the Dominican Republic as described in section 3—with equal probability. Assuming a 10% profit margin and fixed costs, this small variation in prices generates 10% variation in profits, and the expected incremental income of the long-term asset would have to be 177 pesos per month (11% higher) in order for the firm to invest today. At 20% profit variability, the threshold level of expected monthly profits rises to 198 pesos, 24% higher than in the absence of uncertainty.

This example is perhaps overly stylized. Nevertheless, it draws in stark relief the potential magnitude of the uncertainty effect on investment decisions. Moreover, this effect results entirely from the option value of delaying uncertain, irreversible investments. It assumes risk neutrality or complete markets such that the firm can completely diversify away all income risk, i.e., the firm maximizes net present value but with the added possibility of delay. Neither of these assumptions are likely to hold among small businesses in less developed countries, for whom risk markets are incomplete and risk aversion is important. Together, these factors accentuate the distortion of price uncertainty on investment decisions.

It is worth noting that these distortions do not necessarily imply a reduction in long-term capital stock. Bloom (2000) shows that while the real option effect of uncertainty can explain large elasticities of short-run investment, it does not affect long-term investment. He points out that while real option motives increase the investment threshold, reducing investment in times of strong demand, they also lower the disinvestment threshold, reducing the rate of disinvestment when demand is weak. In both cases, uncertainty has a cost—it pushes firms from their instantaneously optimal level of capital—but it does not reduce long-term investment through the real option effect. In the case of microenterprises, for which low levels of initial fixed assets limit the scope for downward adjustment, this reduced threshold for disinvestment may be less of a factor. As shown by a number of authors (e.g., Caballero 1991, Lee and Shin 2000, Pindyck 1993, Sakellaris 1994) when starting from a base of zero initial capital stock, the real option effect of uncertainty unambiguously reduces investment.

2.2 A Two-Factor Model of Investment Behavior

We conclude this section by examining an investment model with two lines of capital: long-term assets, which are partially irreversible; and working capital, which is freely adjustable. This model is common through the irreversible investment literature and represents a special case of those presented by Abel and Eberly (1996), Eberly and Van Mieghem (1997) and Dixit (1997), among others. The firm's revenue function takes the form

$$R(X, K, S) = X^{\gamma} K^{\alpha} S^{\beta}, \tag{1}$$

where K represents long-term capital and S represents short-term or working capital, and X represents an index of demand and productivity conditions. Assume labor is fixed and normalized to one. This revenue function can be derived from an underlying Cobb-Douglas production function and a constant elasticity demand function.[5] We assume, as is standard, that the productivity index evolves according to a geometric Brownian motion with positive drift μ and variance σ^2. We assume that the cost of each type of capital is r. However, long-term capital is costly to reverse, such that the proceeds from selling a unit of K are $r(1-\theta)$, where $\theta \in [0,1]$ represents adjustment frictions.[6]

[5]Following Eberly and Van Mieghem (1997), this is the same function used by Bertola (1987) and Dixit (1989).

[6]Note that the cases $\theta = 0$ and $\theta = 1$ represent full flexibility and complete irreversibility, respectively.

We state the firm's optimization problem as

$$\begin{aligned} V(X_t, K_t, S_t) &= \max_{I_{Kt}, I_{St}} R(X_t, K_t, S_t) - C(I_{Kt}, I_{St}) \\ &\quad + \frac{1}{1+\rho} E_t \left[V(X_{t+1}, (K_t + I_{Kt})(1-\delta), (S_t + I_{St})(1-\delta) \right], \end{aligned}$$

where ρ is the discount rate, δ is the depreciation rate, I_{jt} is the investment in capital of type $j \in \{K, S\}$ at time t, and $C(I_K, I_S) = r\{I_S + I_K(1 - \theta\ \mathbf{1}(I_K < 0)\}$ is the investment cost function, where $I_K < 0$ implies disinvestment in the long-term asset. Both forms of capital evolve according to $I_{j,t+1} = (j_t + I_{jt})(1 - \delta)$.

In continuous time, the Bellman equation associated with this optimization problem is

$$\rho V(X, K, S) = X^\gamma K^\alpha S^\beta - \delta(V_K K + V_S S) + \mu X V_X + \frac{1}{2}\sigma^2 X^2 V_{XX},$$

where V_j represents the partial derivative of V with respect to j.

As is well known, the general solution to this problem is characterized by a regions of inaction over which K does not change. Figure 1 shows the optimal policy in the space of two variables, (k, s), defined as

$$k = \log(K/X), \quad s = \log(S/X).$$

In the region of inaction, marked by the bold segment in figure 1, the marginal gain to increasing K, $\partial V/\partial K$, is less than r, the unit cost of increasing K. Similarly, the marginal gain to decreasing K, $-\partial V/\partial K$, is less than $r(1-\theta)$. In this simple, two-factor model where only one of the capital inputs is subject to asymmetric adjustment costs, the optimal mix of capital will always reside along this bold segment. Abel and Eberly (1996) show that uncertainty increases the separation between the marginal product of capital that justifies investment and the marginal product of capital that justifies disinvestment. Graphically, this lengthens the region of inaction. In practice, increased uncertainty makes investment behavior in long-term assets more cautious. This implies that in periods of high uncertainty, we are likely to see fewer borrowers making *any* fixed asset investments.

As noted by Nilsen and Schiantarelli (2003) and Doms and Dunne (1998), empirical investigation of firm-level investment models under uncertainty are complicated by the rarity of observations with zero investment in any period. That is not the case for our data, where only approximately 5% of borrowers report intending to make a fixed asset investment during any loan cycle. While this allows us to directly test the prediction that fewer firms will make any fixed asset investments in periods of heightened uncertainty, limitations on our measurement of sales data and firm-level demand shocks prevent us from testing directly other predictions of this model, including convexity in response of investment to demand shocks.

In a more general setting, Eberly and Van Mieghem (1997) demonstrate that in the presence of uncertainty, $S/(K+S)$, the share of total assets in working capital, will be bounded below by its optimal level in the absence of uncertainty. This is because the firm prefers to use working capital, the flexible factor, when long-term assets are subject to asymmetric adjustment cost. This distorts investment away from its optimal composition in the absence of uncertainty.

3 Dominican Inflation Data

This section presents estimates of inflation uncertainty in the Dominican Republic. Inflation uncertainty is measured by the conditional variance of inflation, where inflation is modeled as an autoregressive conditional heteroskedastic (ARCH) process (Engle 1982). The ARCH family of models have a number of virtues for estimating time-series models, but for our purposes their most important feature is that they provide estimates of the conditional variance of disturbances in each period, $\widehat{u_t^2}$. It is these predicted values that will serve as our estimates of inflation uncertainty. This analysis follows closely a long line of similar work in the United States (Engle 1983, Cosimano and Jansen 1988, Huizinga 1993, Jansen 1989).

The basic structure of the univariate ARCH can be written as

$$\pi_t = \beta' \mathbf{x}_t + u_t, \tag{2}$$

with π_t as the dependent variable and $\mathbf{x}_t$ the vector of explanatory variables, which can include lagged values of π, and u_t, the stochastic disturbance term. Conditional on the information set, Ψ_{t-1}, this disturbance is distributed

$$u_t | \, \Psi_{t-1} \sim N(0, h_t). \tag{3}$$

Unlike standard models, the variance of the disturbance is allowed to evolve over time as a function of past realizations of variables, including disturbances. In the standard ARCH model introduced by Engle (1982), the conditional variance of the disturbance term follows an AR process such that

$$E(u_t^2 | \, \Psi_{t-1}) = h_t = \eta_0 + \eta_1 u_{t-1}^2 + \eta_2 u_{t-2}^2 + \cdots + \eta_p u_{t-p}^2, \tag{4}$$

where the lag length, p, defines the order of the ARCH process. By allowing h_t, the variance of the disturbance in period t, to be a function of past realizations of the disturbance itself, this formulation can capture explicitly the observed phenomenon that large and small forecast errors tend to cluster together in the inflation time series. Once we have specified equations (2) and (4), the model is easily estimated via maximum likelihood.

The generalized autoregressive conditional heteroskedastic (GARCH) model proposed by Bollerslev (2001) lets the conditional variance depend on an infinite number of lags of u_t^2 by amending equation (4) to include lags of the expected variance term itself,

$$h_t = \eta_0 + \eta_1 u_{t-1}^2 + \eta_2 u_{t-2}^2 + \cdots + \eta_p u_{t-p}^2 + \xi_1 h_{t-1} + \xi_2 h_{t-2} + \cdots + \xi_q h_{t-q}. \tag{5}$$

Disturbance terms of this form are said to follow a GARCH(q, p) process. Bollerslev demonstrates that a GARCH model with a small number of terms performs as well or better than an ARCH model with many. As shown below, that is also the case for this analysis of Dominican inflation data.

To calculate the measure of monthly inflation uncertainty that will serve as the key explanatory variable in the analysis to follow, I estimate univariate ARCH and GARCH models of the form described in equation (2) where π_t is the monthly percentage change in the consumer price index for the Dominican Republic as reported by the Central Bank of the Dominican Republic,[7] and $\mathbf{x}_t$ includes only lagged values of π_t. Figure 1 shows monthly and annual inflation levels over the period from January 1982 to February 2008.

I estimate both models with lag lengths of 1, 3, and 6 for the autoregressive terms of π in the main estimating equation. I consider ARCH processes (equation 4) of the same lag lengths as well as GARCH$(1, 1)$ and GARCH$(1, 3)$ processes (equation 5).

Table 2 presents summary statistics evaluating the fit—the log likelihood along with the Akaike and Bayesian information criteria—for selected models. Results are not sensitive to the model specification and so the remainder of the analysis will use the first-order GARCH model, which is preferred by both information criteria. The first-order GARCH model also achieves the best information criteria when the inflation process is estimated over the shorter period from January 1998 to February 2008, which overlaps with the period for which we have detailed loan data for Dominican microenterprises. Lagrange multiplier and l tests (Cumby and Huizinga 1992) cannot reject the hypotheses that the remaining residuals in this specification are homoskedastic.

[7] *Indice de precios al consumidor.*

Figure 2 plots the estimated inflation uncertainty, i.e., $\hat{u}_t$, from January 1983 through February 2008.[8] There is substantial variation in inflation uncertainty over the period, ranging from a low of 0.73 percent in August 1998 to a high of 4.80 percent in April 2004. While the series is punctuated by periods of extreme volatility, such as seen in the first half of 2004, the level of uncertainty is consistently high throughout. The mean conditional standard deviation of inflation is 1.30 percent. The comparable value for U.S. inflation volatility is 0.25 percent, less than 20% of that experienced in the Dominican Republic. In fact, the lowest level of Dominican inflation volatility recorded over the sample period is more the 60% larger than the highest level experienced in the United States. This highlights the importance of understanding the effect of inflation uncertainty on investment behavior in less developed countries, where prices tend to be relatively unstable.

4 Dominican Microenterprise Data

The primary firm-level data used in this analysis are an unbalanced panel of loan administrative data from the clients of ADOPEM, a large and well-performing microfinance institution based in the Dominican Republic. ADOPEM is a savings and credit bank based in Santo Domingo, Dominican Republic and serving primarily low-income, urban individuals. Ninety percent of ADOPEM's loans during 2006 were for amounts between RD$2,500 and RD$50,000 ($70-$1,400), and approximately 77% of their 50,000 active clients are women.

ADOPEM routinely collects summary balance sheet and profit and loss account data from all individuals that borrow from it at the time of any new loan solicitation. The available data span from January 1998 through February 2008; however, as described below, data coverage varies throughout the sample. The full sample includes 453,165 firm-loan observations on 173,841 unique firms. Of these, 105,065 firms have more than one loan

[8] The first twelve months of data are used to "season" the estimation.

recorded in the data.[9]

These data are quite rich and include information on sales, default and late performance, fixed asset and working capital balances at the time the loan is made, and business type.[10] Of note and unusual for a microfinance institution, for slightly more than 10% of our sample they also include self-reported use of proceeds at the time of the loan. Such self-reported investment intentions capture exactly the behavior of interest: borrowers' planned investment allocation between short- and long-term assets. This data was collected by the microfinance institution for purely informational purposes and had no bearing on the lending decision.[11] Borrowers were free to use the funds for another purpose at any time during the life of the loan. Thus we presume that borrowers did not have an incentive to misrepresent their intentions.

Table 3 presents summary statistics at the firm-loan level for the entire sample and for just those reporting use of proceeds. In real 2006 terms, the average loan size over the sample is RD$15,045, or approximately $440 at then-current exchange rates, for the sample of all loans and RD$21,031 among those loans for which use of proceeds data is available. Interest rates averaged 42.6% over the sample. The mean level of business fixed assets is RD$25,053; however, the distribution of assets is heavily right skewed, with a median of only RD$1,940. This pattern is similar, if somewhat less skewed, for those reporting use of proceeds. Their mean business assets are RD$39,280 and the median is RD$13,150. The median level of intended investment in additional business fixed assets is zero, with only 5% of borrowers expressing an intention to invest in *any* fixed assets. This is consistent with the theory of optimal investment under uncertainty, discussed in section 2.2, in which investments in

[9] This includes all firms with a non-zero borrowing amount in ADOPEM's administrative loan database.

[10] All quantitative variables were truncated at the 1st and 99th percentiles in order to limit the effect of outliers and remaining errors in the data. All of the results presented below are robust to censoring rather than truncating these outliers.

[11] ADOPEM employs a formula-based lending system under which the maximum borrowing amout is determined as a function of monthly repayment capacity. Self-reported use of proceeds does not enter into this calculation, and both credit officers and potential borrowers are aware of this fact.

assets with asymmetric adjustment costs exhibit hysteresis.

5 Empirical Strategy

This sections describes the empirical strategy for linking inflation uncertainty with the investment behavior and business outcomes of Dominican microfinance borrowers. The investment behavior outcomes of interest are borrowers' planned real investment in long-term assets, the share of loan proceeds they intend to allocate to working capital, and whether a borrower intends to make *any* long-term investments. The key explanatory variable in each case is our measure of inflation uncertainty at the time of loan origination, obtained as described in section 3. Turning to business outcomes, the panel aspect of the borrower-loan data allows assessment of sales and asset growth in response to inflation uncertainty over the term of the loan. Using the same framework, we can also analyze loan performance measures, in particular, late payments and default.

5.1 Uncertainty and investment choice

Denote y_{it} as the value of the outcome of interest (e.g., planned real investment in long-term assets) for individual i at time t and u_t as our measure of inflation uncertainty, obtained from the fitted GARCH residuals as described in section 3. The most basic specification simply considers the conditional mean of this outcome, y_{it}, with respect to inflation uncertainty, u_t, in regression form:

$$y_{it} = \alpha_1 + \beta_1 u_t + \varepsilon_{it}. \tag{6}$$

We can augment equation 6 in a number of ways. First, we can take advantage of the detailed microdata and control for a vector of firm characteristics, $\mathbf{X}$, including trailing sales, loan size, borrowing history and business type:

$$y_{it} = \alpha_2 + \beta_2 u_t + X_{it}\delta_2 + \varepsilon_{it}. \tag{7}$$

Repeat borrowers represent 60% of the unique firms in the data and 85% of all loan-borrower observations. For such borrowers we can also utilize the panel aspect of the data to control for unobserved borrower characteristics. The corresponding estimation equation that includes borrower-level fixed effects is

$$y_{it} = \alpha_3 + \beta_3 u_t + \tilde{X}_{it}\delta_3 + \lambda_i + \varepsilon_{it}. \tag{8}$$

Controls for other measures of systemic risk and general economic activity, including inflation levels, exchange rate levels and volatility, and national income can be included each of these specifications. In all of the regressions, standard errors are clustered to adjusted for possible correlation at the *barrio* (neighborhood) level. Following the same basic framework, I also estimate linear probability and probit models for the intention of borrowers to make *any* investment in fixed assets. As shown in section 2.2, increased uncertainty should be associated with a reduced probability of making any such investments.

5.2 Instrumenting for endogenous timing of borrowing decisions

To the extent that we find a relationship between inflation uncertainty and investment behavior, selection may provide part of the explanation. For example, an inflation-sensitive borrower may postpone taking a loan during periods of high uncertainty. This would lead us to underestimate the effect of inflation uncertainty on investment choice as such borrowers would only reappear in our sample once uncertainty had fallen. Such timing changes may themselves have policy relevance; however, we are interested in the direct relationship between inflation uncertainty and investment choice.

The repeat nature of microfinance borrowing provides an instrument which we can use to overcome this potential selection effect. Sixty five percent of borrowers take out another loan within one month of the due date of their previous loans. Thus I repeat the above analysis instrumenting for the uncertainty level at the time of borrowing with the uncertainty level at the time each borrower's previous loan came due.[12]

5.3 Uncertainty, business outcomes, and loan performance

Estimation of the relationship between inflation uncertainty, business outcomes and loan performance follows the same basic methodology described in section 5.1 above. Real sales, business fixed assets, and home fixed assets serve as the key measures of business and asset growth. For each, the associated dependent variable is calculated as the annualized real growth in the underlying measure

$$\Delta y_{it}^{ra} = \left(y_{it+1}^{r} / y_{it}^{r} \right)^{\tau_{it}} - 1,$$

where y_{it}^{r} is the value of y for borrower i at time t in real 2006 Dominican pesos and τ_{it} is inverse of the amount of time, in fractions of a year, between observations t and $t+1$. Because these measures evolve over the term of the loan, the mean level of inflation uncertainty over the six months after borrowing, $\bar{u}_t^6 = \frac{1}{6} \sum_{i=1}^{6} \hat{u}_{t+i}$, provides the key explanatory variable.[13] Using this measure, I estimates models of the form

$$\Delta y_{it}^{ra} = \alpha_4 + \beta_4 \bar{u}_t^6 + X_{it} \delta_4 + \varepsilon_4, \tag{9}$$

[12] The validity of this instrument relies on the identifying assumption that the uncertainty environment at the time of a borrower's previous loan affects her current investment decisions only through its effect on the timing of future borrowing. Under this assumption, the instrumental variables estimates provides an unbiased estimator for the effect of inflation uncertainty on investment decisions for those individuals who borrow again. It does not account for those borrowers who, in response to the uncertainty environment, never borrow again and hence do not reappear in the sample.

[13] Six months was chosen to cover the loan life for 90% of borrowers. The mean loan term is 10 months, and results are robust to extending to 9 or 12 months the window over which inflation volatility is measured.

where X_{it} includes borrower characteristics as well as measures of GNP growth, inflation rates, and exchange rates, also over the life of the loan.

Default rates and late payment days reported in the microfinance institution's administrative database provide indicators of loan performance. I calculate the effect of inflation uncertainty on these measures using specifications of the form described in (9).

5.4 Uncertainty and Investment Deferral

Finally, we look for evidence of deferred investment in response to past uncertainty. The combination of uncertainty and partially irreversible investment leads firms to be more cautions in their investment decisions. But if firms respond only by delaying investments until the uncertainty is resolved, investment levels would rebound in subsequent periods and the long-term level of investment would equal that when delay was not possible (Bloom 2000). We would therefore expect that, conditional on the current environment, higher levels of past uncertainty would be associated with higher intended investment in long-term assets. Using the panel aspect of the data, we test for this by adding measures of uncertainty, demand growth (as measured by GNP), and their interaction to investment model specifications described above. We estimate models of the form

$$y_{it} = \alpha_5 + \beta_5 u_t + \phi^u \bar{u}^6_{t-1} + \phi^6 g_{t-1} + \phi^{ug} \bar{u}^6_{t-1} g^6_{t-1} + X_{it}\delta_5 + \varepsilon_{it}. \tag{10}$$

Where g^6_{t-1} represents the level of GNP growth over the first six month of the previous loan's term. If firms long-term investments rebound after periods of uncertainty are resolved, we would expect $\phi^{ug} > 0$.

6 Results

This section explores the empirical relationship between inflation uncertainty and small firms' investment decisions. The results suggest that periods of high inflation volatility are associated with lower intended investment in fixed assets as well as reduced growth in both business fixed assets and revenues. This association is robust to controlling for inflation levels, GNP growth, and exchange rates, as well as restricting our attention to within-borrower behavior and instrumenting for the possibly endogenous timing of borrowing decisions.

6.1 Uncertainty and investment choice

Table 4 presents the results for the effect of inflation uncertainty on total intended investment in long-term assets (in real 2006 Dominican pesos) and the share of total loan proceeds used for working capital (short-term assets).[14] The first column presents the results from a regression that includes the level of inflation uncertainty (as measured by the estimated conditional standard deviation of inflation from the GARCH model described in section 3) and the inflation level in the month the loan originated. Consistent with the hypothesis that increased uncertainty distorts individuals' investment decisions away from long-term assets, the coefficient on inflation uncertainty is negative and significant. A one percent increase in inflation uncertainty, approximately 1.15 standard deviations over the analysis period, is associated with a reduction in intended fixed asset investment of RD$362. Column 2 presents results for a similar regression that extends the set of controls to include one-year trailing inflation and GNP growth as well as the current exchange rate and the level of exchange rate uncertainty (estimated using the same GARCH method employed for inflation uncertainty). Column 3 adds firm and loan characteristics including quintic polynomial for loan size and sales, an indicator for whether the loan was for a new or repeat borrower, and categorical

[14] The reported standard errors in all regressions are adjusted for heteroskedasticity and clustering at the neighborhood (*barrio*) level.

variables for business type. Columns 4 and 5 report the results of panel data regressions that include borrower fixed effects. In all specifications, the coefficient on inflation uncertainty is negative and significant, ranging from a RD$135 to RD$362, relative to a mean investment of RD$990.

The bottom of table 4 reports results with the same set of explanatory variables using the share of loan proceeds intended for working capital. The same pattern is evident. In all specifications, increased inflation uncertainty is associated with an increased share of loan proceeds intended for working capital and a corresponding decrease in the share intended for fixed assets.

We also consider the possibility that inflation uncertainty affects borrowers' decisions to make any long-term investment. Table 5 presents the results of probit and linear probability model specifications of this hypothesis, using the same set of explanatory variables described above. In each specification, the coefficient is negative and significant. A one percentage point increase in the standard deviation of inflation is associated with a reduction of 0.73% to 1.66% in the probability a borrower reports an intention to make any long-term investment. This effect is large relative to the mean value of 3.7%.

6.2 Instrumenting for endogenous timing of borrowing decisions

The consistency of parameter estimates over cross-sectional and fixed effects panel regressions suggests that increased uncertainty does affect borrowers' decisions. As described above, observed reductions long-term investments could be the result of both distortions to the investment choices of individuals who borrower regardless the level of uncertainty and distortions in the timing of borrowing decisions.

Table 6 reports the results from the instrumental variables specification, instrumenting for inflation uncertainty and the other included macro-level explanatory variables with the corresponding amounts at the time a borrower's previous loan came do. In all specifications, the coefficients on inflation volatility in the month of borrowing suggest reduced investment in long-term assets in periods of high uncertainty. The parameter estimates are broadly in line with those from the comparable OLS specifications, although they are no longer significant in the more demanding specifications.

6.3 Uncertainty and observed growth

Utilizing the panel aspect of the data, this section explores the relationship between inflation uncertainty and both sales and asset growth. First, this data allows us to investigate the correlation between stated use of proceeds and observed asset growth. Over the period in question, ADOPEM's loans were intended for business purposes (typically referred to as "income generating assets" by microfinance institutions). When soliciting a loan, potential borrowers needed to provide a valid business rationale for the loan proceeds.[15] Conditional on stating a general business purpose, self-reported use of proceeds at the time of the loan was collected by ADOPEM for purely informational purposes and had no bearing on the lending decision. Borrowers did not have an incentive to misrepresent their intentions and were free to use the funds for another purpose at any time during the life of the loan. Expressed intentions do offer some predictive power. A regression of observed changes in fixed assets on intended investment produces a coefficient of 0.15 with a standard error of 0.07, clustering errors at the *barrio* level. Borrowers who state that they intend to invest in fixed assets record a larger increase in fixed assets than those who do not.

Table 7 presents evidence on the relationship between business growth and inflation uncertainty over the life of the loan. The top panel reports results from a regression of the annualized percentage growth in sales on inflation volatility, GNP growth, and changes in inflation and exchange rates, all measured over the first six months of the loan.[16] Column 1

[15] Cash, however, is fungible and uses of proceeds are difficult to monitor. In practice, most microfinance institutions tacitly accept non-business uses of proceeds ranging from consumption to education and housing. Many are moving to offer loans specifically targeting such purposes.

[16] Six months was chosen because substantially all loans are outstanding for this duration. The results are

presents results from the basic specification, column 2 adds borrower and loan-level controls, and column 3 presents results using borrower fixed effects. In all specifications, increased inflation uncertainty over the first six months of the loan is associated with substantially and significantly lower real sales growth. A one-standard deviation increase in six-month volatility (0.65 percentage points) corresponds to a reduction in real, annualized revenue growth of between 9 and 19 percentage points, relative to a median growth rate of 11% and a mean of 76%.

Turning to the evolution of assets, the second panel of table 7 shows increased inflation uncertainty is also associated with large decreases in fixed asset growth in borrowers' businesses. A one-standard deviation increase in six-month volatility corresponds to a reduction of between 7 and 12 percentage points in fixed asset growth. GNP growth over the first six months of the loan is also consistently associated with larger real growth in both revenues and business fixed assets. While the direction of these effects is consistent a negative association between inflation uncertainty and investment, their magnitudes are implausibly large and merit further exploration.

In contrast to business assets, growth in fixed assets for the home does not appear to vary with inflation uncertainty. Only in the fixed effects regression, shown in column 3, is the coefficient on inflation uncertainty significantly different from zero, and then only marginally. This is, perhaps, not surprising as firm profits tend to be more volatile than prices and thus the option value of deferring business investment is more sensitive to uncertainty than that of deferring consumption.

6.4 Uncertainty and loan performance

This final subsection looks at the relationship between inflation uncertainty and loan repayment performance as measured by default experience and late payments. The results in this

robust to alternative window lengths. Note that for a borrower to be included in this analysis, she must have a future loan with income statement detail in the database.

area, as shown in table 8, are less clear to interpret. The first panel presents the results of an ordinary least squares regression of the number of days which payments were late over the loan cycle on inflation uncertainty, change in inflation, GNP growth, and the change in the peso-dollar exchange rate over the first six months of the loan. As before, column 1 presents results from the basic specification, column 2 adds borrower and loan-level controls, and column 3 presents results using borrower fixed effects. If inflation uncertainty causes repayment difficulty for microfinance borrowers, we would expect it to have a positive coefficient in these regressions. While this is the case for the specifications presented in columns 1 and 2, the effect disappears in the fixed effects specification. Late payments, which average 5.3 days throughout the sample, fall during periods of high GNP growth and when the value of the Dominican peso falls relative to the U.S. dollar. Many borrowers receive substantial remittances from emigrant family members and few purchase imported goods other than with these remittances. Thus, the large positive effect of the weakening peso may be the product of remittances sent in fixed dollar amounts. However, more evidence is required to test this hypothesis.

The second and third panels of table 8 show the results of the probit and linear probability regressions for an indicator of default on the same set of explanatory variables.[17] They are perplexing. Default rates average 3.1% throughout the sample, and tend to be lower during periods of inflation uncertainty. Moreover, the coefficients on both GNP growth and exchange rates are the reverse of what one would expect based on the late payment behavior. Periods of increased economic activity and a declining peso are associated with higher default rates despite reductions in late payments. Understanding the roots of this relationship offers an avenue for future research.

[17] I do not estimate the fixed effects regression for default behavior. Once a borrower defaults, she is unlikely to appear in the dataset again.

6.5 Uncertainty and Investment Deferral

Finally, we look for evidence of deferred investment in response to past uncertainty, estimating equation 10 with total fixed asset investment, share of investment intended for working capital, and the probability of any fixed asset investment as the dependent variables. Table 9 reports the results of these regressions, and there is some evidence of deferred compensatory behavior in each case. In panel A, the coefficient on the interaction of inflation uncertainty and GNP growth during the prior loan cycle is positive in all specification, although it is significant at the 5% level only in the fixed effects regression without controls for other macroeconomic factors, column 4. Similarly, the coefficients on the interaction term in panel B are consistently negative, implying that the combination of high inflation uncertainty and positive aggregate demand shocks during the term of a borrower's previous loan is associated with a smaller share of loan proceeds going towards working capital during the current loan cycle. Panel C shows that such periods also correspond to a higher future probability of any fixed asset investment, but the effects are not evident in the fixed effects regressions shown in columns 4 and 5. Note that in each case the main effects of inflation uncertainty and GNP growth during the prior loan period push investment behavior in the opposite direction of the interaction term, and the combined effect does not offset the distortion away from long-term assets associated with contemporaneous uncertainty.

These results should not be taken as a rejection of the deferred investment prediction from some real options investment models. The period between loan cycles may be too short to capture any deferrals, and further research is required to fully test this hypothesis.

7 Conclusion

This paper presents evidence that in periods of high inflation uncertainty, small businesses reduce their investment in long-term assets. Moreover, increased inflation uncertainty over the term of the loan is associated with lower real sales growth, even after accounting for other sources of systemic uncertainty and general economic growth.

This line of research extends existing work on the relationship between inflation uncertainty and investment in two important directions. First, it utilizes a unique panel of microfinance borrower data to analyze the effect of inflation uncertainty on firm-level behavior. In doing so, it take a step towards understanding the foundation of the negative relationship between inflation uncertainty and investment that is typically observed at the country and industry level. Second, it extends our understanding of this relationship in less developed countries where inflation volatility tends to be high and the mechanisms available to cope with risk are limited.

Given the magnitude of borrowers' responses to inflation uncertainty, it is tempting to draw welfare conclusions. However any efforts to do so are subject to two important caveats. First, the measured declines in fixed asset growth, intended investment, and revenues are all relatively short term, occurring over a single year. Over the longer term, uncertainty may also dampen downward adjustment of capital stock in response to negative shocks leaving total investment unchanged. While such barriers to adjustment impose a cost on firms, we do not measure their effects here, and the long-term effect on capital stock remains ambiguous. Second, the welfare consequences of investment in micro-businesses are not well known. Their owners' alternative uses of capital include consumption smoothing and human capital investments, and understanding the relative welfare consequences for different uses of loan proceeds remains an open and important research question. The decision not to invest in fixed assets may also move borrowers across the entry-exit margin. Exploration of the relationship between systemic uncertainty and occupational choice provides an interesting avenue for future research.

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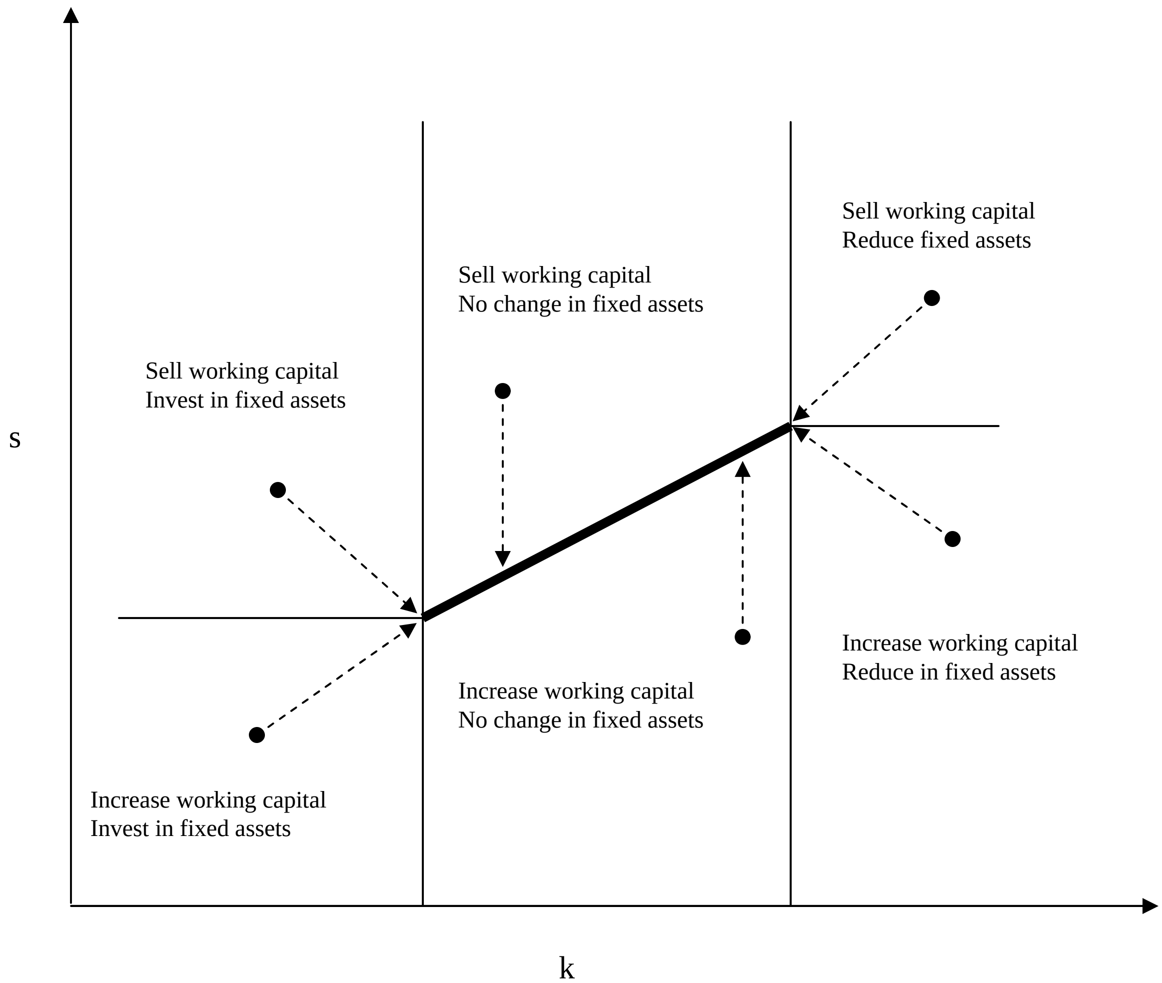
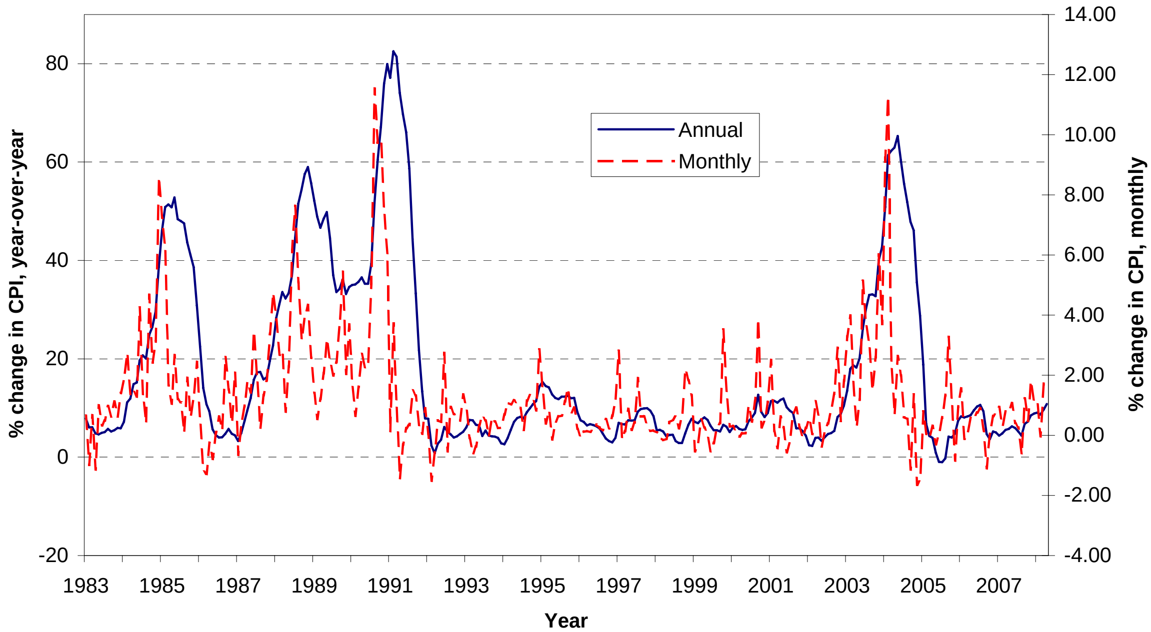
Figure 1: Optimal Investment Policy



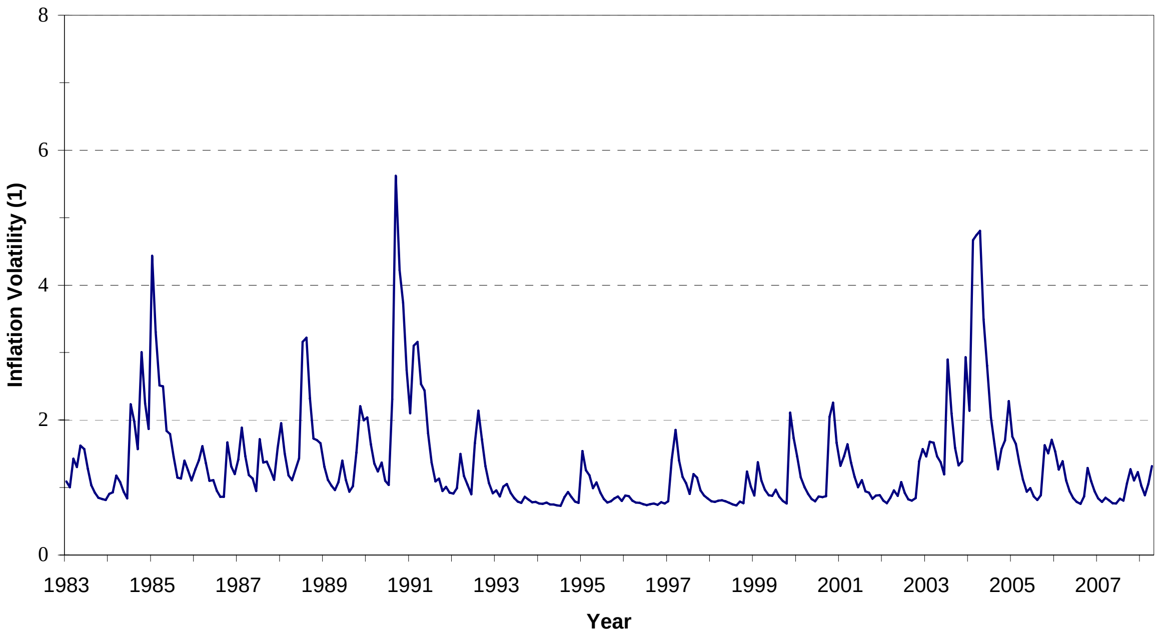
Notes: *s*=log(*S/X*) and *k*=log(*K/X*) where *S* represents short-term assets (working capital), *K* represents long-term assets, and X represents the index of demand and productivity conditions. Dashed arrows indicate optimal policy responses.

Figure 2: Dominican Republic Consumer Price Inflation
January 1983 to April 2008



Notes:
(1) Percent change in seasonally adjusted consumer price index *indice de precios al consumidor* .

Figure 3: Dominican Republic Monthly Consumer Price Inflation Volatility
January 1983 to April 2008



Notes:

(1) Conditional standard deviation of seasonally adjusted consumer price index indice de precios al consumidor, calculated based on GARCH(1,1) model.

Table 1: Investment Decision, The Effect of Uncertainty

Initial capital expenditures	8,000		
Monthly discount rate	2%		
	Certain Profit Stream	Uncertain Profit Stream	
		Profit stream ±50% resolved in one month	
Invest today	Certain	High	Low
Probability	- -	0.50	0.50
Monthly expected profits	200	300	100
Discounted value of profits	10,000	15,000	5,000
Expected NPV	2,000	2,000	
Wait for one month and decide			
Monthly expected profits	200	300	100
Discounted value of profits	10,000	15,000	5,000
NPV		7,000	(3,000)
Expected NPV	2,000	3,500	(1,500)
Make investment	*yes*	*yes*	*no*
Expected NPV		3500	0
Expected NPV	2000	3500	
Discounted NPV	1,961	3,431	
Optimal strategy	***Invest today***	***Wait***	

Notes: Corresponds to the investment choice and uncertainty example discussed in section 2, which follows closely work by Huizinga (1993) and Pindyck (1991).

Table 2: ARCH Model Diagnostics

	ARCH Model 1 (1)	ARCH Model 2 (2)	ARCH Model 3 (3)	GARCH Model 1 (4)	GARCH Model 2 (5)
AR (p)	1	1	3	1	1
ARCH (q)	1	3	3	1	3
GARCH (r)	- -	- -	- -	1	1
Full Inflation Series (1982m1-2008m4)					
Unconditional variance	2.64	2.29	2.24	2.29	2.32
log likelihood	927.6	945.7	947.0	946.5	947.4
AIC	-1847.1	-1879.5	-1878.0	-1882.9	-1880.8
BIC	-1832.1	-1856.9	-1848.0	-1864.2	-1854.6
Investment Data Period (1998m1-2008m2)					
Unconditional variance	2.88	n/a	n/a	2.08	n/a
log likelihood	367.5	n/a	n/a	374.6	n/a
AIC	-727.0	n/a	n/a	-739.2	n/a
BIC	-715.7	n/a	n/a	-725.1	n/a

Notes: These are estimation results for equations (x) through (x) with lag lengths as indicated. AIC is the Akaike Information Criterion and BIC is the Bayesian Information Criterion.

Table 3: Summary Statistics for Borrower Data

A. Loan Characteristics	All Loans Mean (1)	All Loans Median (2)	All Loans Standard Deviation (3)	Use of Proceeds Data Available Mean (1)	Use of Proceeds Data Available Median (2)	Use of Proceeds Data Available Standard Deviation (3)
Actual loan size, real	15,045	9,951	16,297	21,031	15,443	18,016
Sales, real	32,563	21,758	35,553	36,571	29,000	27,435
Annual interest rate (%)	42.6	48.0	19.2	53.7	60.0	9.7
Default rate (%)	3.1	0.0	17.4	1.4	0.0	11.7
Days late payment during loan	5.3	0.0	27.5	15.5	0.0	47.9
Fixed assets, business, real	25,053	1,940	67,634	39,280	13,150	74,238
Fixed assets, home, real	217,937	163,776	230,998	224,818	155,286	238,797
Share of requested amount intended for working capital				96.6	100.0	18.0

B. Business Types	All Loans n	All Loans %	Use of Proceeds Data Available n	Use of Proceeds Data Available %
Clothing store	111,264	24.6%	9,408	19.8%
Convenience store or grocery	139,990	30.9%	13,879	29.3%
Restaurant	24,310	5.4%	4,511	9.5%
Personal care	54,247	12.0%	8,293	17.5%
Other	123,354	27.2%	11,352	23.9%
Total	453,165		47,443	

Notes: Real amounts based on Dominican consumer price index, January 2006.

Table 4: Inflation Uncertainty and Investment Choice

Intended Asset Allocation

	(1)	(2)	(3)	(4)	(5)
A. Intended investment, fixed assets (real)					
Inflation uncertainty, month of borrowing	-362.6 ***	-135.3 ***	-192.2 ***	-273.7 ***	-277.2 *
	(66.1)	(38.4)	(42.1)	(91.5)	(144.5)
Inflation level, month of borrowing	-44.8 ***	-80.0 ***	-104.1 ***	-46.6	-163.6 ***
	(13.4)	(23.9)	(22.7)	(30.7)	(60.6)
Inflation level, year-over-year		-51.3 ***	-54.6 ***		-76.2 ***
		(8.9)	(9.2)		(22.6)
GNP Growth, year-over-year		15.0	17.3		10.7
		(24.6)	(25.6)		(42.7)
Exchange rate, month of borrowing		148.1 ***	161.5 ***		194.3 ***
		(26.6)	(28.2)		(50.3)
Exchange rate uncertainty, month of borrowing		-1.4	0.5		2.5
		(1.5)	(1.3)		(2.7)
B. Share of loan intended for working capital (%)					
Inflation uncertainty, month of borrowing	1.25 ***	0.64 ***	0.63 ***	0.78 ***	0.90 ***
	(0.30)	(0.13)	(0.13)	(0.22)	(0.22)
Inflation level, month of borrowing	0.18 ***	0.25 ***	0.24 ***	0.10 *	0.33 ***
	(0.04)	(0.06)	(0.05)	(0.06)	(0.08)
Inflation level, year-over-year		0.11 ***	0.10 ***		0.14 ***
		(0.03)	(0.03)		(0.04)
GNP Growth, year-over-year		-0.02	-0.02		-0.04 **
		(0.02)	(0.01)		(0.02)
Exchange rate, month of borrowing		-0.19 ***	-0.19 ***		-0.24 ***
		(0.05)	(0.04)		(0.07)
Exchange rate uncertainty, month of borrowing		-0.01 ***	-0.01 ***		-0.02 ***
		(0.00)	(0.00)		(0.00)
Controls					
Sales (quintic polynomial)	-	-	x	x	x
Loan size (quintic polynomial)	-	-	x	-	-
New or repeat borrower	-	-	x	-	-
Business type	-	-	x	-	-
Individual Fixed Effects	-	x	-	x	x
N	47,443	47,443	47,443	31,076	31,076

Notes: Dependent variable listed in italicized panel heading; regressors below. Table reports coefficient estimates with robust standard errors, clustered at *barrio*, in parentheses. *** Significant at 1%; ** significant at 5%; * significant at 10%. Loan size is quintic polynomial of total real loan amount, business type includes indicators for clothing stores, food stores, restaurants, beauty & fashion and other. Fixed effects regressions include only those borrowers reporting multiple loans.

Table 5: Inflation Uncertainty and Investment Choice

Any Intended Fixed Asset Investment

	(1)	(2)	(3)	(4)
A. Any fixed asset investment, Probit Marginal Effect at means (%)				
Inflation volatility, month of borrowing	-1.66 ***	-1.10 ***	-1.10 ***	
	(0.10)	(0.14)	(0.14)	
Inflation level, month of borrowing	-0.25 ***	-0.33 ***	-0.33 ***	
	(0.04)	(0.04)	(0.04)	
Inflation level, year-over-year		-0.13 ***	-0.13 ***	
		(0.01)	(0.01)	
GNP Growth, year-over-year		0.04	0.05	
		(0.03)	(0.03)	
Exchange Rate		0.41 ***	0.40 ***	
		(0.02)	(0.02)	
Exchange Rate Volatility		0.00	0.00 **	
		(0.00)	(0.00)	
B. Any fixed asset investment, Linear Probability Model (%)				
Inflation volatility, month of borrowing	-1.22 ***	-0.73 ***	-0.78 ***	-1.35 ***
	(0.06)	(0.09)	(0.09)	(0.18)
Inflation level, month of borrowing	-0.17 ***	-0.28 ***	-0.30 ***	-0.38 ***
	(0.02)	(0.03)	(0.03)	(0.06)
Inflation level, year-over-year		-0.16 ***	-0.17 ***	-0.19 ***
		(0.01)	(0.01)	(0.02)
GNP Growth, year-over-year		0.17 ***	0.16 ***	0.11 **
		(0.04)	(0.04)	(0.06)
Exchange Rate		0.49 ***	0.50 ***	0.45 ***
		(0.02)	(0.02)	(0.04)
Exchange Rate Volatility		0.00	0.00	0.01 ***
		(0.00)	(0.00)	(0.00)
Controls				
Loan Size	-	-	x	-
New or repeat borrower	-	-	x	-
Business type	-	-	x	-
Individual Fixed Effects	-	-	-	x

Notes: Dependent variable listed in italicized panel heading; regressors below. Table reports coefficient estimates with standard errors in parentheses. Linear probability model errors are clustered at the *barrio* level. *** Significant at 1%; ** significant at 5%; * significant at 10%. Loan size is quintic polynomial of total real loan amount, business type includes indicators for clothing stores, food stores, restaurants, beauty & fashion and other. Fixed effects regressions include only those borrowers reporting multiple loans.

Table 6: Inflation Uncertainty and Investment Choice

Instrumenting based on due date of previous loan

	(1)	(2)	(3)	(4)	(5)
A. Total investment, fixed assets					
Inflation volatility, month of borrowing	-472.3 ***	346.3	156.5	-285.7	79.6
	(141.6)	(304.5)	(300.2)	(207.0)	(601.6)
Inflation level, month of borrowing	-125.3 **	-261.3 ***	-237.7 **	-67.7	-276.5 **
	(62.1)	(94.4)	(97.0)	(77.2)	(131.1)
Inflation level, year-over-year		-97.9 ***	-91.0 ***		-69.8 **
		(21.6)	(22.9)		(31.5)
GNP Growth, year-over-year		-123.9 *	-99.7		-41.2
		(65.4)	(65.6)		(80.2)
B. Share of loan used for working capital (%)					
Inflation volatility, month of borrowing	1.47 ***	-0.36	-0.38	0.71 **	1.90 **
	(0.26)	(0.56)	(0.56)	(0.31)	(0.91)
Inflation level, month of borrowing	0.46 ***	0.73 ***	0.70 ***	0.26 **	0.30
	(0.12)	(0.17)	(0.18)	(0.12)	(0.20)
Inflation level, year-over-year		0.29 ***	0.27 ***		0.11 **
		(0.04)	(0.04)		(0.05)
GNP Growth, year-over-year		0.23 *	0.22 *		-0.25 **
		(0.12)	(0.12)		(0.12)
C. Any fixed asset investment, Linear Probability Model (%)					
Inflation volatility, month of borrowing	-1.41 ***	0.37	0.37	-0.72 **	-1.81 *
	(0.27)	(0.58)	(0.58)	(0.32)	(0.93)
Inflation level, month of borrowing	-0.45 ***	-0.76 ***	-0.73 ***	-0.25 **	-0.33
	(0.12)	(0.18)	(0.19)	(0.12)	(0.20)
Inflation level, year-over-year		-0.29 ***	-0.27 ***		-0.12 **
		(0.04)	(0.04)		(0.05)
GNP Growth, year-over-year		-0.26 **	-0.24 *		0.21 *
		(0.13)	(0.13)		(0.12)
Controls					
Sales (quntic polynomial)	-	-	x	x	x
Loan size (quintic polynomial)	-	-	x	-	-
New or repeat borrower	-	-	x	-	-
Business type	-	-	x	-	-
Individual Fixed Effects	-	-	-	x	x
N	30,396	30,395	30,395	23,922	23,922

Notes: Dependent variable listed in italicized panel heading; regressors below. Table reports coefficient estimates with robust standard errors, clustered at *barrio* , in parentheses. *** Significant at 1%; ** significant at 5%; * significant at 10%. Loan size is quintic polynomial of total real loan amount, business type includes indicators for clothing stores, food stores, restaurants, beauty & fashion and other. Fixed effects regressions include only those borrowers reporting multiple loans. Inflation uncertainty and all other macro economic variables at time of loan instrumented for with corresponding variables at time prior loan came due.

Table 7: Inflation Uncertainty, Asset and Revenue Growth

	(1)	(2)	(3)
A. Sales, annualized percentage change			
Inflation volatility, first 6 months of loan	-14.92 ***	-29.36 ***	-21.52 ***
	(3.85)	(6.14)	(4.25)
Inflation level, month of borrowing	-0.57	1.74 ***	1.71 ***
	(0.45)	(0.64)	(0.46)
GNP Growth, first 6 months of loan	0.74 ***	0.92 ***	1.55 ***
	(0.12)	(0.19)	(0.28)
Change in inflation, first 6 months of loan	-1.31 ***	-0.65 ***	-1.03 ***
	(0.14)	(0.24)	(0.17)
Change in exchange rate, first 6 months	-0.21	1.19 ***	-0.12
	(0.32)	(0.32)	(0.38)
B. Business fixed assets, annualized percentage change			
Inflation volatility, first 6 months of loan	-11.77 *	-13.75 **	-18.85 ***
	(6.07)	(5.40)	(7.10)
Inflation level, month of borrowing	3.42 ***	4.18 ***	6.34 ***
	(1.00)	(1.09)	(1.44)
GNP Growth, first 6 months of loan	0.97 ***	0.72 ***	1.36 ***
	(0.28)	(0.21)	(0.26)
Change in inflation, first 6 months of loan	-0.63	-0.11	-0.41
	(0.41)	(0.40)	(0.40)
Change in exchange rate, first 6 months	1.13	1.20	1.54
	(1.00)	(0.89)	(1.00)
C. Home fixed assets, annualized percentage change			
Inflation volatility, first 6 months of loan	1.82	0.58	-8.24 *
	(4.25)	(4.14)	(4.59)
Inflation level, month of borrowing	-0.34	-0.18	1.98 **
	(0.84)	(0.84)	(1.00)
GNP Growth, first 6 months of loan	0.18	0.11	0.75 ***
	(0.12)	(0.11)	(0.15)
Change in inflation, first 6 months of loan	-0.59 *	-0.41	-0.39
	(0.36)	(0.35)	(0.38)
Change in exchange rate, first 6 months	-1.23 **	-1.08 *	-0.72
	(0.62)	(0.60)	(0.60)
Controls			
Sales (quntic polynomial)	-	x	x
Loan size (quintic polynomial)	-	x	-
New or repeat borrower	-	x	-
Business type	-	x	-
Individual Fixed Effects	-	-	x

Notes: Dependent variable listed in italicized panel heading; regressors below. Table reports coefficient estimates with robust standard errors, clustered at *barrio*, in parentheses. *** Significant at 1%; ** significant at 5%; * significant at 10%. Loan size is quintic polynomial of total real loan amount, business type includes indicators for clothing stores, food stores, restaurants, beauty & fashion and other. Fixed effects regressions include only those borrowers reporting multiple loans.

Table 8: Inflation Uncertainty and Default Rates

	(1)	(2)	(3)
A. Days Late			
Inflation uncertainty, first 6 months of loan	6.13 ***	5.84 ***	0.03
	(0.10)	(0.11)	(0.33)
Change in inflation, first 6 months of loan	0.08 ***	0.08 ***	-0.13 ***
	(0.01)	(0.01)	(0.04)
GNP Growth, first 6 months of loan	-0.25 ***	-0.25 ***	-0.23 ***
	(0.01)	(0.01)	(0.02)
Change in exchange rate, first 6 months	-0.94 ***	-0.93 ***	-0.68 ***
	(0.02)	(0.02)	(0.08)
B. Default Rate, Probit Marginal Effect at means (%)			
Inflation uncertainty, first 6 months of loan	-3.52 ***	-2.92 ***	
	(0.09)	(0.08)	
Change in inflation, first 6 months of loan	-0.01	-0.01 *	
	(0.01)	(0.01)	
GNP Growth, first 6 months of loan	0.20 ***	0.17 ***	
	(0.01)	(0.01)	
Change in exchange rate, first 6 months	0.23 ***	0.21 ***	
	(0.02)	(0.02)	
C. Default Rate, Linear Probability Model (%)			
Inflation uncertainty, first 6 months of loan	-2.56 ***	-2.21 ***	
	(0.05)	(0.05)	
Change in inflation, first 6 months of loan	-0.05 ***	-0.05 ***	
	(0.01)	(0.01)	
GNP Growth, first 6 months of loan	0.11 ***	0.10 ***	
	(0.00)	(0.00)	
Change in exchange rate, first 6 months	0.23 ***	0.21 ***	
	(0.01)	(0.01)	
Controls			
Loan size (quintic polynomial)	-	x	-
New or repeat borrower	-	x	-
Business type	-	x	-
Individual Fixed Effects	-	-	x

Notes: Dependent variable listed in italicized panel heading; regressors below. Table reports coefficient estimates with robust standard errors, clustered at *barrio* , in parentheses. *** Significant at 1%; ** significant at 5%; * significant at 10%. Loan size is quintic polynomial of total real loan amount, business type includes indicators for clothing stores, food stores, restaurants, beauty & fashion and other. Fixed effects regressions include only those borrowers reporting multiple loans.

Table 9: Inflation Uncertainty and Investment Choice

Intended Asset Allocation, Long Term Effects and Postponement

	(1)		(2)		(3)		(4)		(5)	
A. Intended investment, fixed assets (real)										
Inflation uncertainty, month of borrowing	-229.0	***	-181.8	*	-233.1	***	-206.4	**	-109.8	
	(49.5)		(94.1)		(84.0)		(83.3)		(198.5)	
Inflation uncertainty, prior loan period	-92.7		-115.1		-294.9	*	197.9		245.3	
	(142.7)		(183.8)		(155.9)		(241.5)		(273.2)	
GNP growth, prior loan period	-188.5	***	-134.5		-64.8		-355.5	***	-324.4	**
	(64.0)		(85.8)		(63.6)		(100.7)		(125.7)	
Inflation uncertainty x GNP growth, prior loan period	94.9	*	61.3		8.1		195.0	**	180.6	*
	(55.7)		(69.2)		(57.3)		(85.6)		(103.3)	
B. Share of loan intended for working capital (%)										
Inflation uncertainty, month of borrowing	0.85	***	1.00	***	1.01	***	0.70	***	1.23	***
	0.23		0.29		0.26		0.21		0.34	
Inflation uncertainty, prior loan period	0.22		0.59		1.07	***	-0.41		-0.07	
	0.28		0.41		0.34		0.31		0.36	
GNP growth, prior loan period	0.63	***	0.36	***	0.14		0.61	***	0.40	***
	0.13		0.13		0.10		0.18		0.15	
Inflation uncertainty x GNP growth, prior loan period	-0.33	***	-0.16	**	0.01		-0.33	***	-0.19	**
	0.07		0.08		0.08		0.09		0.08	
C. Any fixed asset investment, Linear Probability Model (%)										
Inflation uncertainty, month of borrowing	-0.86	***	-0.93	***	-0.67	***	-0.81	***	-0.85	***
	0.07		0.14		0.07		0.12		0.12	
Inflation uncertainty, prior loan period	-0.36	**	0.52	*	-0.38	**	-0.70	***	-1.02	***
	0.16		0.31		0.16		0.21		0.21	
GNP growth, prior loan period	-0.37	***	-0.54	***	-0.43	***	-0.21	**	-0.09	
	0.09		0.16		0.09		0.10		0.10	
Inflation uncertainty x GNP growth, prior loan period	0.14	**	0.28	**	0.19	***	0.05		-0.04	
	0.07		0.11		0.07		0.07		0.07	
Controls										
Sales (quintic polynomial)	-		-		x		x		x	
Loan size (quintic polynomial)	-		-		x		-		-	
New or repeat borrower	-		-		x		-		-	
Business type	-		-		x		-		-	
Individual Fixed Effects	-		x		-		x		x	
Other macro environment†	-		x		x		-		x	
N	47,443		40,144		40,144		31,076		25,998	

Notes: Dependent variable listed in italicized panel heading; regressors below. Table reports coefficient estimates with robust standard errors, clustered at barrio, in parentheses. *** Significant at 1%; ** significant at 5%; * significant at 10%. Loan size is quintic polynomial of total real loan amount, business type includes indicators for clothing stores, food stores, restaurants, beauty & fashion and other. Fixed effects regressions include only those borrowers reporting multiple loans. † Coefficients for current inflation levels, current GNP growth, and exchange rates are supressed.