Inventories and Risk in African Manufacturing

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Abstract

This paper analyses the effects of risk on the holding of inventories and liquid assets by manufacturing firms. Using a panel data set for Zimbabwe which includes firm-specific measures of contractual risk, we show that contractual risk has a major effect on the holding of stocks of inputs and, to a lesser extent, the constitution of cash reserves. This is consistent with the role of inventories as a hedge against stockout risk. By contrast, we find that firms facing more inter-annual market risk hold less inventories. This suggests that African manufacturers prefer adapting to long-term market fluctuations as they materialize rather than building up inventories. This interpretation is consistent with the finding that high market risk firms also have a low capacity utilization rate.

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1. Introduction

According to economic theory, one key reason for firms to hold inventories and liquid assets is the presence of risk. This idea is best exemplified by stockout inventory models (e.g. Holt et al. (1960), Blinder (1982, 1986), Eichenbaum (1989)) in which firms build up inventories to avoid stocking out when faced with demand shocks or late input delivery. The same reasoning applied to liquid assets predicts that firms will build up cash reserves to deal with market fluctuations and late payment by clients (e.g., Tsiang (1969)). The stockout motive is but an application of the precautionary savings idea (e.g., Deaton (1991), Zeldes (1989)) to inventories and cash reserves. The purpose of this paper is to test the stockout motive by investigating whether contractual risk (interruptions in payments or in deliveries of inputs) and market risk (unforeseen fluctuations in demand) affect the inventories and cash reserves held by manufacturers. Our econometric analysis is based on a panel survey of 200 manufacturers in Zimbabwe, interviewed over a period of three years.

As far as we know, we are the first to make use of firm-specific data on contractual risk. Our data set helps us to overcome many of the problems which have plagued earlier empirical work. First, the data allow us to analyse inventories directly: unlike much earlier work, we do not rely on an accelerator model (e.g., Irvine (1981), Darling and Lovell (1971), Ghali (1974)) or variance test approach (e.g., West (1986), Eichenbaum (1989), Miron and Zeldes (1988), Naish (1994)). Secondly, since we use firm-level data our results do not, unlike those of Eichenbaum (1989), West (1986), Milne (1994), and Cuthbertson and Gasparro (1993), rely on time series properties that are notoriously sensitive to measurement error. Thirdly, the use of firm-specific data (as in Lieberman (1980) and McIntosh et al. (1993)) avoids the aggregation bias that has plagued much of the analysis to date (see discussions in Blinder and Maccini (1991), Caplin (1985), Mosser (1991)). Finally, while much of the literature focuses on a single type of inventory (e.g., Irvine (1981), Eichenbaum (1984), Blanchard (1983), Miron and Zeldes (1988), West (1986)), we follow Lieberman (1980) and Ramey (1989) and simultaneously study three types of physical inventories and one type of liquid asset.

That our data set is for an African economy is fortuitous but fortunate. Manufacturing firms in Africa operate in a very risky environment (see e.g. Collier and Gunning (1999)) while financial market imperfections severely limit their options for dealing with risk. If the stockout motive is relevant anywhere it should be in such economies rather than in developed economies where contract compliance is much better, input markets are thick and sophisticated, and financial instruments are available to help firms deal with risk.

We have two key findings. First, there is strong evidence that the risk of delayed deliveries and payments explains much of the inventory and liquidity reserve behaviour of manufacturers. Our results therefore support recent efforts to explain inventory accumulation from the stockout motive (e.g., Abel (1985), Kahn (1987), Krane (1994)). But while the literature has focused almost exclusively on market fluctuations (see Blinder and Maccini (1991) for references) our results highlight the importance of contractual risk, that is, of imperfect contract compliance by clients and suppliers. Secondly, in contrast to much of the empirical literature on the stockout motive (e.g. Ramey (1989), Cuthbertson and Gasparro (1993)) we find that market risk has a *negative* effect on inventories, even after controlling for credit availability. Results also suggest that demand shocks raise inventories, especially of goods in progress and finished products. In addition, we find that high market firms have a lower capacity utilization rate. We interpret these findings as tentative evidence that manufacturers seek to adapt to market fluctuations by remaining flexible, i.e., by holding excess capacity but few inventories.

The econometric analysis presented here agrees with qualitative information collected during the survey. Conversations with survey respondents indicated that one of the major benefits of the structural adjustment program adopted in Zimbabwe in 1991 was to increase the reliability of input deliveries. This has led, according to respondents, to a drastic reduction in inventories of inputs and to the gradual disappearance of the practice of input sharing (e.g., Free University of Amsterdam (1995), Fafchamps, Pender and Robinson (1995)).[1] Results also agree with the fears of contractual risk often expressed by respondents who tried or considered exporting their products. Similar concerns were expressed by manufacturers in other African countries (e.g., Fafchamps (1996b), Fafchamps et al. (1994)) and by American and European firms trying to source products from Africa (Biggs et al. (1994)). Concerns about contractual risk across national boundaries may thus be a serious hindrance to manufacturing exports from Africa. Finally, if our interpretation regarding firms' desire for flexibility is correct, the extent and type of market risk that African manufacturers face may explain both why capacity utilization is low and production erratic. This issue deserves more research.

The structure of the paper is as follows. In Section 2 we discuss the various motives for holding inventories and use stylized models to derive testable implications. While many of the predictions about inventory holding are common to the various motives, we

[1] Prior to the liberalization of foreign exchange and international trade in the early 1990's, Zimbabwean manufacturers used to informally borrow inputs and equipment from each other. This practice seem to have developed during the Unilateral Declaration of Independence period (1965-1979) as a result of the economic embargo imposed on Zimbabwe. The extreme shortages of inputs and the spirit of defiance prevalent at the time helped the emergence of this unusual risk sharing institution reminiscent of village solidarity mechanisms (e.g., Fafchamps (1992), Coate and Ravallion (1993)). The presence of this institution constitutes further confirmation of the role that risk plays in inventory management.

show that the effect of contractual risk on inventories of inputs is unique for the stockout motive. In section 3 we present the survey data and discuss our measure of contractual risk. The econometric analysis is presented in section 4 for contractual risk and in sections 5 and 6 for market risk.

2. The Theory of Inventories and Liquidity Reserves

The literature has suggested essentially three motives why firms hold inventories and liquidity reserves: minimization of transactions and switching costs; production smoothing; and stockout risk (e.g., Holt et al. (1960), Blinder and Maccini (1991), Ramey (1989), Bental and Eden (1993)). Rather than integrating the three motives in a single model[2] we focus on each motive separately and we derive, for each of them, simple testable predictions about the level of inventories or liquidity reserves held by individual firms. This approach has the advantage of clarity and simplicity.

We begin with the minimization of transactions costs. The existence of fixed ordering costs is, by itself, sufficient to induce firms to hold inventories of inputs because firm economize on ordering and delivery costs by bunching orders. This idea can easily be formalized as follows. Let ordering costs be composed of a fixed cost per transaction K and a variable cost c proportional to the size of the order. Let I denote the size of the order and assume for the time being that delivery is instantaneous. Further assume that the firm requires a constant daily input supply f. An order of size I thus lasts I/f days. Suppose that storage and capital costs r are proportional to the size of the stock. Since

[2] See Tsiang (1969) and Caplin (1985) for an integration of transactions costs and stockout motives. Holt et al. (1960) and Blanchard (1983) integrate production smoothing and stockout risk as adjustment costs in a linear-quadratic inventory model. Abel (1985) and Krane (1994) examine more general models that combine stockout and production smoothing motives.

delivery is instantaneous and storage costly, there is no reason for the firm to order before stocks are exhausted. The total storage and capital costs associated with one order are thus $r \frac{1}{2} I\,(I/f)$. The firm minimizes average daily costs as follows:

$$\underset{I}{Min}\ \frac{1}{I/f}(K + c\,I + r\,½\,I\,(I/f)) \tag{1}$$

Straightforward derivation yields the following optimal order size:

$$I^* = \sqrt{\frac{2\,f\,K}{r}} \tag{2}$$

The average stock H is $\frac{I^*}{2}$; it increases with fixed transactions costs and decreases with storage and capital costs. Inventories are proportional to the square root of f, the firm's daily needs of inputs. Since f is in general proportional to total sales, we see from equation (2) that inventories increase less than proportionally with sales. The time between orders is $\sqrt{\frac{2\,K}{r\,f}}$: the larger the firm, the larger f, and the shorter the length of time elapsed between orders.

If we introduce a length of time D -- say one month -- between order and delivery, the optimal order size is unchanged as long as $D \le \sqrt{\frac{2\,K}{r\,f}}$. The only difference is that the firm orders before stocks are exhausted. If, however, $D > \sqrt{\frac{2\,K}{r\,f}}$ and forward orders are not possible,[3] H is then simply equal to $D\,f$: firms order their monthly input requirements each month. In this case, average inventories are directly proportional to total sales. These simple ideas can similarly be applied to production switching costs and

[3] This is a reasonable assumption for Zimbabwe where just-in-time delivery is still unheard of. See Kaplinsky (1994) for a discussion of the difficulties associated with just-in-time delivery in less sophisticated economies.

asset liquidation costs: firms economize on the cost of changing from one type of output to another by producing in batches and accumulating finished products; they may also hold cash reserves if cash is required for payments and if fixed transactions costs must be incurred when liquidating other assets (e.g., Tsiang (1969)).

The presence of uncertainty or variability in input requirements and sales generates other reasons for holding stocks, namely, the production smoothing and the stockout motives. Since the seminal work of Holt et al. (1960), much of the literature on inventories has focused on the production smoothing motive (see Blinder (1982), Blinder and Maccini (1991) and the references cited in the introduction). To illustrate this principle, consider a monopolist living for two periods who can accumulate stocks of finished products H by incurring a storage cost r.[4] The firm has a quadratic cost function $\frac{1}{2} c\, q^2$ and faces a linear inverse demand $p = a - \frac{1}{2} b\, s + \theta_t$ where a, b and c are parameters, p is price, q is production, s is sales, and θ_t is a demand shock at time t with $E[\theta_t] = 0$. Profit maximization in the second period yields:

$$q^* = \frac{a + \theta_2 - b\, H}{b + c} \tag{3}$$

In the first period, the firm must decide not only how much to produce -- q -- but also how much to store -- H. We assume a zero initial stock. The firm's optimization problem is:

$$\underset{q,\ H \geq 0}{Max}\ (a - \frac{1}{2}\, b\, (q - H) + \theta_1)(q - H) - \frac{1}{2}\, c\, q^2 - r\, H + \beta E[\pi(H,\ \theta_2)] \tag{4}$$

where θ_1 is the realized demand shock in period 1, β is the firm's discount factor, and

[4] The same results can be obtained for a competitive firm facing uncertain selling price and for long-lived firms (e.g., Holt et al. (1960), Blinder (1982, 1986), Eichenbaum (1984)). For simplicity, we focus here on a two-period example.

$\pi(H, \theta_2)$ is the second period profit function implied by (3). Straightforward derivation yields:

$$H^* = Max[\frac{\beta a - (a + \theta_1) - r\frac{b+c}{c}}{b(1+\beta)}, 0] \qquad (5)$$

Equation (5) predicts that inventories fall with the storage cost r and with the discount rate implicit in β. It also indicates that firms stock up whenever the level of current demand, indicated by $a + \theta_1$, is low relative to future expected demand a. The reason is that marginal costs increase with output: stocking up when production costs are low enables firms to reduce average production costs in anticipation of higher future demand. This effect is similar to that of anticipated higher sales in the pure transactions cost model.

This example illustrates two important features of the production smoothing motive. First, whenever the cost function is convex and demand variable or uncertain, firms can reduce production costs by smoothing output over time. This does not require the presence of uncertainty: variations in demand, even if perfectly predictable -- e.g., seasonal -- would equally result in inventory accumulation (e.g., Miron and Zeldes (1988)). Second, because $\pi(H, \theta_2)$ is quadratic in H, storage is not a function of the variance of demand shocks. This result is of course an artifact of our choice of functional form, e.g., linear demand and quadratic cost function, but it emphasizes the distinction between production smoothing and precautionary savings, which is known to depend critically on the third derivative of the agent's objective function (e.g., Zeldes (1989), Kimball (1990)). It also serves to stress that the production smoothing motive need not be sensitive to the variance of demand. Storage does, however, respond negatively to *current* demand shocks θ_1 and positively to *anticipated* future shifts in demand a, as in the transactions cost model.

The stockout risk motive generates another, distinct reason for holding stock. It is based on the idea that firms may suffer a loss if they run out of stock: e.g., retailers may lose sales and even customers if they run out of goods; manufacturers may be unable to produce if they are short of an essential input; and agents may damage their reputation if they fail to pay banks and suppliers. The stockout risk motive does not require marginal costs to be increasing, an assumption that has become contentious after Ramey (1991) provided empirical evidence that marginal production costs may be decreasing. For this reason, the stockout motive has attracted renewed interest recently (e.g., Abel (1985), Kahn (1987), Krane (1994), Bental and Eden (1993)). To illustrate how it differs from production smoothing concerns, consider our monopolist again. Suppose that the firm faces a constant marginal cost c (no production smoothing motive) but production of one unit of output requires α units of an essential input that cannot be obtained on short notice.[5] The firm can anticipatively hoard this input H at cost r. For simplicity, we assume that the firm cannot postpone delivery and backlog demand.[6] Profit maximization in the second period yields:

$$q^* = Min[\frac{a + \theta_2 - c}{b}, \alpha H] \tag{6}$$

with corresponding profit function:

$$\pi(H, \theta_2) = (a - ½\, b\, q^* + \theta_2)\, q^* - c\, q^* \tag{7}$$

From equations (6) and (7) we see that there is a 'kink' in the profit function at the point where $\alpha H = \frac{a + \theta_2 - c}{b}$ or, alternatively, where:

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[5] The same results can be obtained for finished products if production takes time, or for retailers' inventories if orders reach the shop with a lag.

[6] Krane (1994) shows that the stockout motive applies even when firms can backlog demand.

$$\theta_2^* = b\,\alpha\,H - a + c \qquad (8)$$

For $\theta_2 < \theta_2^*$, the input requirement constraint is not binding and profits do not depend on H; for $\theta_2 > \theta_2^*$, they do. The first period decision to store H is the solution to the following optimization problem:

$$\underset{H \geq 0}{Max}\ -r\,H + \beta \int_{-\infty}^{\theta_2^*} \pi(\theta_2) dF(\theta_2) + \beta \int_{\theta_2^*}^{\infty} \pi(H,\ \theta_2) dF(\theta_2) \qquad (9)$$

where $F(\theta_2)$ is the cumulative distribution function of θ_2. The first order condition for H can be written:

$$\frac{r}{\alpha\beta} = \int_{\theta_2^*}^{\infty} (\theta_2 - \theta_2^*) dF(\theta_2) \qquad (10)$$

where θ_2^* is the linear function of H given by equation (8). It is easy to show from equation (10) that optimal storage H^* falls with storage cost r and rises with discount factor β.[7] To examine how risk affects inventory accumulation, let parameter λ represent an arbitrary mean preserving transformation of the distribution of θ_2. An increase in λ translates into a mean preserving spread of θ_2. Totally differentiating (10) with respect to H and λ, we get:

$$\frac{d\,H^*}{d\,\lambda} = -\frac{\beta\alpha}{SOC} \frac{\partial}{\partial\,\lambda} [\int_{\theta_2^*}^{\infty} (\theta_2 - \theta_2^*) dF(\theta_2)] \qquad (11)$$

Since the second order condition SOC must be negative for an interior optimum, the sign of $dH^*/d\lambda$ depends on the effect of λ on the integral term. This effect is necessarily positive. To see why, define function $\phi(\theta)$ such as $\phi(\theta) = \theta - \theta^*$ if $\theta > \theta^*$, and 0 otherwise. Equation (11) can be rewritten:

$$\frac{d\,H^*}{d\,\lambda} = -\frac{\beta\alpha}{SOC} \frac{\partial}{\partial\,\lambda} [\int_{-\infty}^{\infty} \phi(\theta_2) dF(\theta_2)]$$

[7] Since r and β do not appear on the right-hand side, the result is obtained by totally differentiating equation (10) and using the fact that the second-order condition is negative.

Since function $\phi(\theta)$ is convex, by Jensen's inequality, any mean preserving transformation of $F(\theta_2)$ raises the value of the integral.

Inventories are thus an increasing function of the variance of sales.[8] This is the stockout motive. In contrast to concerns for production smoothing, it is clearly a form of precautionary saving as defined by Kimball (1990) and Deaton (1991). When demand is constant but deliveries are uncertain, inventories H can similarly be shown to be an increasing function of the risk of non-delivery. The same principles apply to cash reserves as a buffer against liquidity problems resulting from non payment by clients.[9]

From this summary of the literature a number of testable predictions can be identified.[10] Let S_t and H_t denote total sales and end-of-period inventories at time t, respectively. Define expected sales $S_t^e \equiv E_{t-1}[S_t]$ and sales shocks $S_t^s \equiv S_t - S_t^e$. Let Σ be the variance-covariance matrix of market and contractual risk and let σ_{ij} be one element

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[8] Abel (1985), Kahn (1987) and Krane (1994) derive similar results in more general models.

[9] To see why, let B and C stand for amounts due to suppliers and due by clients, respectively. Further assume that payments by clients occasionally fall short of what is anticipated by an amount θ_2. Firms face a cost γ proportional to the gap in their liquidities; γ is taken to represent the cost of emergency funds, the loss of earnings due to the impossibility to purchase supplies, or the lost of reputation and goodwill among suppliers for paying late as result of shortage of liquidity. One could easily imagine more complex liquidity costs (e.g., Tsiang (1969)). But this is not required; showing that stockout risk leads to the accumulation of buffer liquidities is just as easily obtained with a linear penalty function. Second period profits are $Min[\bar{\pi}, \bar{\pi} - \gamma(C + H - B - \theta_2)]$ and the threshold value of θ_2 at which liquidity is exactly 0 is simply $\theta_2^* = C + H - B$. By analogy with the previous example, it is easy to show that the first order condition for H is:

$$\frac{r}{\beta} = \gamma(1 - F(C + H - B))$$

from which it is straightforward to show that buffer liquidities increase with the risk of non-payment by clients.

[10] It is of course possible to combine two or more of these motives into a single model. The well known $(S-s)$ model, for instance, combines transaction and stockout motives. Scarf (1959) was the first to show that when outflows (of goods or cash) are independently distributed over time, it is optimal for firms facing transactions costs to reorder each time inventories fall below a level s, thereby returning them to an upper level S -- hence the $(S-s)$ nickname (see also Tsiang (1969), Caplin (1985), and Mosser (1991)). The implications of the $(S-s)$ rule in the presence of stochastic demand shocks have been derived in Caplin (1985). Kahn (1987), Bentel and Eden (1993), and Krane (1994) present further extensions of the stockout model.

of Σ; for simplicity, we assume that Σ is constant over time. Finally, let β_t and r be the firm's discount factor and storage cost, respectively. We have:

$$H_t = f\,(S_t^e,\, S_t^s,\, \Sigma,\, \beta_t,\, r) \qquad (12)$$

All three models we have presented predict that inventories should decrease when storage costs r rise or the discount factor β_t falls. They also all predict that inventories should increase with the firm's size of operations, i.e., with (expected) sales S_t^e. In the production smoothing and stockout motive, this relationship is expected to be linear, but the transactions cost motive states that inventories will rise proportionally with (expected) sales only if the delivery lag is longer than the speed with with the firm wishes to replenish its stock. Otherwise, they should rise less than proportionally. This can be tested by examining whether $\frac{\partial\, H_t/S_t^e}{\partial\, S_t^e}$ is smaller than 0. If it is, this can be construed as indirect evidence in favor of the transactions cost motive.[11]

The production smoothing and stockout models also predict that realized stocks are a negative function of sales shocks. This is because more sales than anticipated leads to a drop in inventories (e.g., Ramey (1989)). Since the existence of shocks is not essential to the transactions cost motive, we presented a simple model without them. But it is fairly obvious that, even in that case, inventories will be lower if they happen to be depleted faster than anticipated. This can be tested by examining whether inventories drop when actual sales exceed expectations, that is, whether $\frac{\partial\, H_t}{\partial\, S_t^s} < 0$.[12]

[11] Cuthbertson and Gasparro (1993), for instance, report a unit elasticity of manufacturing inventories with respect to output.

[12] By the same token, the production smoothing and stockout motives also predict that an increase in sales expectations will lead, other things being equal, to an instantaneous rise in output (e.g., McIntosh et al. (1993)).

The three models nevertheless differ in several important respects. First of all, the production smoothing motive induces firms to hold stocks of finished products but it does not, by itself, lead them to accumulate inventories of inputs. In contrast, both the transactions cost and stockout motive do. The simple fact that firms hold inventories of inputs therefore provides evidence that at least one of these two motives is present. The models also differ substantially in their predictions regarding variability and risk. The transactions cost motive does not, in its simplest form, produce any relationship between risk and inventories. In contrast, both the production smoothing and the stockout risk motives predict that firms facing more variable sales hold larger inventories of finished products. The two motives nevertheless differ in other critical dimensions, which are summarized in Table 1.

First, only concerns about stocking out lead firms to accumulate inventories against the risk of delayed delivery; the production smoothing motive, by itself, does not. The stockout motive can thus be investigated by testing whether firms facing more contractual risk hold more inventories, that is, whether $\frac{\partial H_t}{\partial \sigma_{ii}} > 0$ where σ_{ii} measures the risk of delayed deliveries.[13] Second, only the production smoothing motive predicts that deterministic seasonal variations in demand lead to higher inventories; the stockout motive does not. The production smoothing motive can thus be tested by examining whether firms facing more seasonal variations in demand hold more inventories. Finally, in contrast to the stockout motive, the production smoothing motive never predicts that firms

[12] In the case of the production smoothing motive, the effect need not, however, be large if production costs are approximately quadratic and demand is linear (see supra).

[13] The same principles apply to cash reserves: the risk of delayed payment by clients should raise cash holdings if firms worry about running out of liquidities. They should also hold more cash if unanticipated variations in demand require firms to incur additional expenditures.

will hold inventories of inputs, even in response to market risk. Testing these predictions is the object of the rest of this paper.

3. The Survey Data

The data used in this study come from a panel of some 200 Zimbabwean manufacturing firms surveyed by a team of researchers coordinated by the World Bank. Zimbabwe is a particularly interesting country to study inventory and liquidity management. It is landlocked and thus dependent on port and transportation facilities in neighbouring countries for some key industrial inputs. Until a drastic structural adjustment and financial liberalization program was launched in 1991, the industrial sector in Zimbabwe was highly monopolistic and firms enjoyed high levels of protection from import competition (e.g., Gunning and Mumbengegwi (1995)). In spite of its small size, Zimbabwe boasts the second most developed manufacturing sector in Sub-Saharan Africa, but firms are small by international standards. Zimbabwe has long historical ties with and exports part of its industrial production to South Africa, its immediate southern neighbour which is also the largest African economy. Zimbabwe has a tightly knit business community, among which are many members of a 100,000 strong white settler minority (e.g., Fafchamps (1998)).[14] Supplier credit is the norm in business, hence opening the door to payment risk (e.g., Fafchamps (1997)).

Panel firms were randomly selected in six sectors of industrial activity: food processing, textile, garment, metal products, wood products, and leather. Sample design is discussed in detail in Bade and Gunning (1994). Very small firms with fewer than 5

[14] This situation is partly a heritage of the 1964-1979 Unilateral Declaration of Independence period during which a white dominated government faced an international embargo and in response developed domestic manufacturing.

employees are excluded from the survey.[15] The firms were visited three times at one year interval -- in 1993, 1994 and 1995 -- and were asked questions on a wide variety of issues. In addition to standard information on finance, employment, capital stock, investment and sales, data were collected on three types of inventories -- inputs, goods in progress, and finished products. For firms with an overdraft facility we used the unutilized part of this facility (i.e., the difference between the ceiling and the balance) as a proxy for cash reserves.[16] Finally, and most importantly, in 1993 firms were asked about various sources of contractual risk: late deliveries, deliveries of deficient quality deliveries, and late and non-payment. These data were used to construct measures of contractual risk.

The unweighted sectoral composition and general characteristics of the sample are detailed in Table 2. Close to half the surveyed firms are in Harare, the capital city; another quarter is in Bulawayo, the second largest town in the country. Half of the firms are headed by descendants of Europeans settlers; one third of the surveyed firms are headed by blacks. The mean, median, 5% and 95% percentiles of sales, employment, and capital are reported in the Table. Figures show that the surveyed firms vary enormously in terms of size. They are also fairly small compared to firms in developed economies: the median firm has 90 employees; the largest some 6000. Median sales are of the order of 300,000 US dollars per year; median capital is half that. Combined inventories represent roughly one tenth of annual sales; they are held mostly in the form of inputs. Inventories of finished products are surprisingly small.

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[15] In terms of sheer number of enterprises, very small firms form the bulk of manufacturing sector. Their share of output, employment, and value added is, however, small. Detailed information on Zimbabwean small enterprises can be found in Daniels (1994).

[16] Information on overdraft ceiling was collected only in 1994 and in 1995.

The most important source of short-term financing is supplier credit: on average it represents roughly one tenth of annual sales. It is followed by overdraft facilities. Two third of the firms have an overdraft facility with a bank. On average, panel firms hold 40% of their overdraft unused, but the median overdraft cash reserve is zero. Data show that the average incidence of contractual problems is high, but there are wide disparities among firms. Delayed payment by clients is the most common contractual risk, followed by late deliveries.[17] Of the four measures of contractual problems on which data were collected, the first two -- late and non delivery and deficient quality of supplies -- are highly correlated. So are the last two -- late and non-payment by clients. We therefore retain two of the four measures in the econometric analysis: late delivery R_i^d to proxy for delivery problems in general, and late payment R_i^l to proxy for payment problems in general.

4. Contractual Risk and Inventories

We first focus on contractual risk. The Zimbabwe panel data is used to estimate a linearized version of equation (11):

$$H_{i,t}^k = \alpha_k + \alpha_d^k R_i^d + \alpha_v^k S_t^e + \alpha_z^k Z_{i,t} + \alpha_m^k D_{i,t} + \varepsilon_{i,t}^k \qquad (13)$$

where $k = 4$: inputs, goods in process, finished products, and cash reserves (unused overdraft reserve and savings reserve); S_t^e stands for expected sales; $\varepsilon_{i,t}^k$ is a random disturbance term; and the α's are parameter vectors to be estimated. Our particular interest is, of course, in coefficient α_d^k that measures the effect of delayed delivery risk on inventory behaviour. Because storage costs are likely to differ between sectors, we include a set of

[17] These results are similar to data obtained in in other African countries (e.g., Fafchamps (1996b), Fafchamps et al. (1994)).

sectoral dummies $Z_{i,t}$. In particular, we expect firms in the food processing sector to hold less inventory because food products are, in general, more perishable (e.g., Schwartz and Whitcomb (1979)). We assume that the cost of capital $\beta_{i,t}$ to all firms varies from year to year as interest rates adjust; this is controled for using yearly dummies $D_{i,t}$. Payment risk R_i^l is added as regressor to the cash reserve regression.[18] An analysis of sales shocks and market risk is delayed until Section 5.

Given the wide disparity of size among the sample firms, we must normalize the observations to make them comparable. From the transactions cost motive, we suspect that inventories are roughly proportional to total sales (e.g., Cuthbertson and Gasparro (1993)). We therefore use as dependent variable the ratio of inventories over total (expected) annual sales, i.e., the dependent variable used throughout is inventories divided by total expected sales $\hat{S}^e_{i,t}$. A detailed discussion of how an estimate of $\hat{S}^e_{i,t}$ is obtained can be found in Section 5. For the moment, it suffices to say that expected sales are computed from a log linear regression of actual sales on employment, capital, and firm-level fixed effects, estimated over five consecutive years. To allow for the possibility that inventories increase less than proportionally with sales, expected sales are included as regressor as well. Because the frequency of contractual problems is highly skewed, contractual risk enters the regression in log form.

Equation (13) is estimated using censored least absolute deviation (CLAD) regressions for inventories of inputs, goods in progress, finished products, and all inventories combined. CLAD estimation has been shown to be less sensitive to departures from the normality assumption that is required to estimate tobit or other maximum likelihood

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[18] Delayed payment risk is omitted from the inventory regressions since it should have no noticeable effect on inventory holdings.

regressions (e.g., Powell (1984)). It is also less sensitive to heteroskedasticity and has consequently become a preferred tool for estimating censored regressions (e.g., Deaton (1997)).[19] Standard errors are computed by bootstrapping with 100 replications.

Estimation results are presented in Table 3. They show that the incidence of delayed deliveries has a strong positive effect on inventory holdings all four regressions, consistent with the stockout motive. The effect is particularly large and significant for input inventories, as one would expect since delayed deliveries first affect a firm's holding of production inputs. These results constitute strong evidence in favor of the stockout motive since they suggest that manufacturing firms hedge delivery risk by building up inventories. Results also indicate that food processors hold comparatively fewer inventories, undoubtedly due to the perishability of their products. All inventories were smaller in 1995, possibly because of high cost of credit in that year (e.g., Free University of Amsterdam (1995)).[20]

Next we estimate similar regressions regarding the use of short-term credit and the existence of an unused line of credit -- what we call an overdraft reserve.[21] Interviews with respondent firms indeed suggest that drawing upon one's overdraft is an important method by which Zimbabwean firms deal with liquidity shortages (e.g., Fafchamps et. al.,

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[19] In our case, very similar results were nonetheless obtained using tobit regressions instead of CLAD.

[20] Interestingly, results also show that large firms hold relatively *more* inventories than small firms, a result in contradiction with the simple transactions cost model presented in Section 2. There we saw that, if all firms face identical transactions costs, small firms order less frequently to economize on these costs -- and therefore hold more inventories relative to their output. One conceivable explanation for our empirical finding is that small firms face a more unstable market and opt for flexible production (e.g., Lucas (1978), Piore and Sabel (1984)). By producing on order, they limit the risk of producing something they cannot sell, hence reducing the need for inventories, especially of goods in progress and finished products. We revisit this issue in Section 5.

[21] As in the case of inventories, we normalize credit variables by dividing them by (predicted) sales. The dependent variable is thus the ratio between the level of credit at the time of the survey, and the total value of annual sales, as predicted by our fixed-effect regression.

1995). Our purpose here is to investigate whether firms constitute an overdraft reserve in anticipation of delayed payments and deliveries.[22]

Results, presented in Table 4, indicate that the actual *use* of overdraft and supplier credit by respondent firms increases with the risk of delayed deliveries. This is hardly surprising given that firms need more funds to finance inventory accumulation. Results also show that firms facing a higher frequency of delayed payments use more short-term credit. Again, this is consistent with expectations: late payment leads firms to borrow to replenish their liquidities. The next two regressions are more directly relevant for our purpose. Results show that firms facing more contractual risk tend to have a higher overdraft facility and to keep a large unused line of credit, presumably to deal with liquidity shortages triggered by late payment and delivery.

The reader might, however, worry about the sensitivity of these results to measurement errors and simultaneity bias. For one thing, our measures of contractual risk are based on recall questions of the number of instances of late delivery and late payment the firm had experienced in the preceding year. These variables are likely to be measured with error and this would bias the estimated effect of contractual risk on inventories towards zero. In addition, the risk variables may suffer from endogeneity with respect to inventories or cash reserves. For instance, firms with high inventories of finished products may have chosen a more aggressive marketing strategy, at the cost of increasing the number of late or non payments.[23] To investigate whether our results are vulnerable

[22] Although delayed deliveries do not affect the firm's liquidities directly, the firm may have to purchase cash inputs from alternative sources to avoid disrupting production.

[23] In the case of inventories, simultaneity bias ought to *reduce* the size of the late deliveries coefficient: presumably, firms that did not receive inputs on time held less inventories than they had intended. One cannot, however, totally rule out the possibility that firms with large inventories sought to purchase inputs from more risky suppliers, thereby incurring a higher frequency of delayed supplies.

to measurement error and simultaneity bias, we reestimate Tables 2 and 3 using predicted contractual risk instead of actual.

Contractual risk is instrumented using the following variables as regressors: (a) firm size (measured by predicted sales), assuming that larger firms pass more transactions and therefore may face more contractual risk); (b) sector of activity (some sectors may be more subject to contractual risk than others); (c) location (deliveries and payments may be more erratic away from the capital city); (d) involvement in international markets, measured by the share of inputs which are imported and the share of output that is exported (contractual risk is probably higher for international transactions due to transport risk and relatively greater monitoring difficulties); and (e) the main supplier's share of the firm's most important input (sloppy contractual performance is more likely with monopolist suppliers). Only (a) and (b) are common variables, also used as regressors in the inventory equations; the others serve as identifying restrictions. There is indeed no reason, other than differences in contractual performance, to believe that inventories should vary with location, involvement in international trade, or supplier monopsony.

The predicting regressions are reported in Table 5. Identifying restrictions are significant: older firms encounter more late delivery problems, while exporting firms are more likely to face late payment.[24] Predicted values from Table 5 are then used as regressors in Tables 6 and 7.[25] To our knowledge, there is no known method for correcting CLAD standard errors when instrumented variables are used as regressors. Reported

[24] The share of imported inputs, though not significant in the CLAD regression, is highly significant in a tobit late delivery regression.

[25] Unlike Tobit, CLAD should remain consistent even in the presence of heteroskedasticity. If we are not mistaken, the use of predicted regressors should thus not result in inconsistent parameter estimates. For the sake of consistency, we use CLAD instead of tobit predictors in spite of the absence of an agreed upon method for correcting endogeneity problems in CLAD regressions. Tobit and CLAD predictors are highly correlated (i.e., >0.95) and yield comparable results when used to instrument contractual risk.

standard errors should thus be treated with caution.[26]

Results, reported in Tables 5 for inventories, overwhelmingly confirm that firms facing more risk of delayed deliveries hold more input stocks: even with a 20% correction (see footnote), reported *t*-values are well above standard levels of significance.[27] Other findings are largely unaffected. Regarding credit and liquidity reserves (Table 7), results now indicate that, unlike in the uninstrumented regression, predicted incidence of late payment is a better predictor of both credit use and liquidity reserve than late delivery. The only possible exception is supplier credit, where delivery risk is marginally significant. These results are consistent with the stockout/precautionary saving theory: one would indeed expect firms facing more cases of late payment both to need more credit and to constitute more reserves.

5. Market Risk, Seasonal Variations, and Inventories

We now turn to market risk and seasonal variations, beginning with the latter. In the survey, firms were asked whether they experience a peak period during the year and, if yes, for how many months and whether the firm is at a peak period at the time of the interview.[28] Whether the firm experiences a peak period is a measure of market seasonality; and whether the peak occurred around the time of the interview is a measure of sales peak.[29] Since seasonal variations can be anticipated, the stockout motive does

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[26] To get a sense of the potential magnitude of the bias in standard errors, we estimated the total inventory regression by 2SLS, with and without standard error correction. Given that there is only a small proportion of censored observations in the case of total inventories, 2SLS is a more or less acceptable estimation method in this case. We found that the corrected standard errors (*t* values) were at most 20 percent larger (smaller) than the uncorrected ones. Since the same regressors are used in all inventory regressions, a similar correction should apply (e.g., Murphy and Topel (1985)).

[27] Similar results are obtained if tobit regression is used instead of CLAD.

[29] These data are admittedly crude since they do not say anything about the magnitude of the difference between peak and non-peak periods.

not apply, but the production smoothing motive is still in force (see Table 1). Results (not shown here for the sake of brevity) show no discernible effect of seasonality variables on inventories, irrespective of the method of estimation or number of other regressors included in the regression.[30] Although we should not make too much of these findings given the crudeness of our seasonality measures, they provide some initial evidence that that the smoothing of production over time is not a key concern of Zimbabwean manufacturers.

The remainder of the section is devoted to the effect of market risk and demand shocks on inventories. Unlike for contractual risk, survey firms were not asked to evaluate the incidence of demand shocks affecting them. A crude measure of firm-specific market risk can nevertheless be constructed by taking the coefficient of variation of annual sales. Firms whose sales vary a lot from year to year are presumably subject to more market risk. A variable representing firm-specific demand shocks can similarly be constructed by taking the difference between actual sales and their firm-specific five year average.

In practice, we construct slightly more sophisticated measures by estimating a firm-level fixed effect regression of annual sales on employment and capital stock. The purpose of this procedure is to purge (as much as is feasible with the data at hand) our measures of market risk and demand shocks from planned expansion and contraction in response to anticipated changes in market conditions. Formally, we assume that the sales $S_{i,t}$ of firm i in year t follow:

[30] This is true even if we restrict the sample to firms who reported sales over a short period, or if we cross market seasonality variables with the recall period dummy. Seasonality also appears unrelated to our measure of inter-annual variance of sales.

$$S_{i,t} = S^{e}_{i,t}\, e^{u_{i,t}} \tag{14}$$

where $e^{u^{s}_{i,t}}$ is a random shock that represents unanticipated variation in sales and has constant firm-specific variance σ^{s}_{i}. To estimate equation (14), we postulate that:

$$S^{e}_{i,t} = L^{\alpha_L}_{i,t}\, K^{\alpha_K}_{i}\, e^{\lambda_i} \tag{15}$$

where $L_{i,t}$ is total firm-level employment in period t, $K_{i,t}$ is capital, and λ_i is a firm-specific fixed effect. Behind equation (15) is the idea that investment and hiring decisions are a good indication of how much firms expect to sell. This procedure is not perfect -- expectations of market risk as perceived by firm managers would be better. But with no such information and with only five years of sales data, this is the best we can do. Firm-level fixed effects control for unobservable factors such as management quality, sub-sector of activity, brand recognition, market power, and the like. The choice of a Cobb-Douglas-like functional form follows by analogy with a production function.[31] Firm-level fixed effects estimates are used to construct predicted expected sales $\hat{S}^{e}_{i,t}$.[32] A firm-specific estimate of σ^{s}_{i} is derived by computing, for each firm separately, the standard deviation of the $e^{\hat{u}_{i,t}}$.[33] The residuals $e^{\hat{u}_{i,t}}$ themselves are used as a measure of unanticipated market shocks $\Delta S_{i,t}$.

Based on the models presented in Section 2, we expect market risk to have a positive effect on inventory holdings -- due to the production smoothing and stockout motives. (Unanticipated) demand shocks are assumed to deplete inventories, that is, to

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[31] Capital stock data are reconstructed on the basis of the 1993 stock of capital and of 1992-1995 investment flows in equipment and machinery. Employment and sales data for 1991 and 1992 are based on retrospective questions.

[32] More precisely, $\hat{S}^{e}_{i,t} \equiv L^{\hat{\alpha}_L}_{i,t}\, K^{\hat{\alpha}_K}_{i,t}\, e^{\hat{\lambda}_i} (\frac{1}{5}\sum_{j=91}^{95} e^{\hat{u}_{i,j}})$. This predicted sales variable is also the one used throughout section 4.

[33] Divided by $\frac{1}{5}\sum_{j=91}^{95} e^{\hat{u}_{i,j}}$ so as to obtain a measure of the coefficient of variation of unanticipated annual sales.

have a negative sign. Another feature of the data must also be briefly discussed. Not all surveyed firms hold detailed accounts and some -- 18% -- could not remember their total sales over the 12 months preceding the survey. These are mostly smaller firms managed by ethnic Africans. When faced with such firms, enumerators were instructed to ask respondents for their total sales over the period they could remember -- typically a month. Annual sales were subsequently reconstructed by multiplying, say, their sales over the last month by 12. Although the procedure reduces recall error among firms with a short memory span, it also raises the variance of their ’annual’ sales, compared with long recall firms for whom short-term fluctuations are averaged out over the entire year. To account for this feature of the data, we let the coefficient of the market risk variable differ between short and long recall firms.[34] We expect inventories in short recall firms to be less sensitive to measured market risk, since in their case the annual variance of sales is probably overestimated.

CLAD regression results, summarized in Table 8, are largely at odds with expectations: market risk has a negative effect on all inventory holdings, and the effect is larger and more significant for short recall firms. This says that, contrary to what would be predicted by the production smoothing and stockout motives, firms facing more variation in their sales hold *less* inventories than firms with a more stable market. This is true for all categories of inventories and the effect is very strong -- both large and highly significant for short recall firms. At the same time, sales shocks have a positive effect on inventories in all regressions, significantly so in the total inventories regression. Contractual risk and the food sector dummy remain significant.

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[34] The cutoff recall period is six months.

To ascertain whether the above findings are robust, we examine various alternative explanations. We first investigate whether our results arise because firms with a high variance of sales shocks are sliding towards bankruptcy. Remember that our measure of market risk is essentially the firm-specific variance of residuals in equation (14). Suppose that certain firms experience large, cumulative drops in sales but fail to fully adjust their capital and labor. By construction, these firms will have a higher residual variance. They are also likely to be cash strapped, reduce inventories and, eventually, go bankrupt. To examine whether this process might account for our results, we decompose our market risk measure into two components: a firm-specific trend in sales shocks and a residual variance around this trend.[35] This procedure should purge our market risk measure from cumulative trend in sales shock. It can also be construed as an additional effort to take out of market risk any trend that could have been anticipated by respondents. Since the production smoothing and stockout models predicts that anticipations of high future sales should raise inventories, we expect the coefficient of the trend variable to be positive.

Results, presented in Table 9, continue to show a negative effect of market risk on inventories, which remains strong and significant for short recall firms. Firm-specific trends have the expected sign and are significant in three of the four regressions. Other regressors are basically unchanged, except that the sales shock variable is no longer significant in the total inventory regression -- probably because of multicollinearity with the trend variable, given that we have at most five observations per firm. We also investigate the bankruptcy hypothesis directly by testing whether high market risk firms are

[35] In practice, we regress, for each firm, residuals from the sales regression on a time trend. The coefficient of the time trend is our firm-specific trend; the standard error of the residuals of this regression is our new measure of market risk.

those with a negative trend. To do so, we regress our initial market risk measure (that used in Table 8) on firm-specific trends. The association turns out to be strongly positive and highly significant: we can thus safely reject the idea that our results are due to bankrupt firms holding fewer inventories.[36]

The second possibility we investigate is that our measures of market and demand shocks are subject to measurement error and, possibly, endogeneity bias. To control for this possibility, we instrument the coefficient of variation of annual sales and rerun the regressions.[37] Recall period is included as instrument, and its effect on the coefficient of variation of sales is taken out of predicted market risk so as to obtain an instrumented measure of market that is free of recall period effects. Results are presented in Table 10. Even instrumented and purged from recall period effects, market risk still has the wrong sign, and is significant in three of the four regressions.

Next we investigate whether these results might be due to a perverse effect of market risk on credit. Regressions of credit use and overdraft ceiling on market risk and demand shocks indeed show a pattern similar to that observed for inventories (Table 11). The effect, however, is less pronounced and not at all significant for overdraft ceiling and overdraft reserve. Still, it is conceivable that our results are due to the fact that high market risk firms get less credit and, as a result, are less able to hold inventories. To investigate this possibility, we include credit availability directly in the inventory

[36] This is true for our short recall and long recall measures of market risk as well.

[37] Contractual risk is instrumented as well, for good measure. Instruments for market risk are: firm location (market risk is likely to be higher in isolated markets); share of output that is exported and exporter dummy (Zimbabwe is landlocked and heavily dependent on transportation and port facilities in neighboring countries); share of output sold to private end-users, and share sold to private retailers and wholesalers (market risk is likely to differ if firms market their products directly to consumers/manufacturers, or rely on specialized intermediaries who can shoulder part of the market fluctuations); and the short recall dummy. We do not have suitable instruments for demand shocks, but the yearly dummies included in the inventory regression capture market shocks common to all firms.

regression; this should eliminate the negative coefficient of the market risk variable if market risk affects inventories only via its effect on credit availability. Results presented in Table 12 demonstrate that this is not the case: although credit availability clearly has a strong, significant effect on inventory holdings, it does not fully eliminate the negative effect of market risk and the positive effect of demand shocks.

Of course, credit availability is potentially subject to endogeneity bias: firms wishing to hold more inventories are likely to request a larger line of credit from their bank. This could affect the estimated coefficient market risk. To control for this possibility, we reestimate the model using instrumented overdraft ceiling, together with instrumented market and contractual risk.[38] The results, presented in Table 13, are slightly less conclusive (fewer regressors are significant) but they essentially display the same pattern: credit matters, but firms that face more inter-annual variations in sales hold smaller inventories. Furthermore, they are shown to increase inventories in response to demand shocks, even after controlling for the effect of such shocks on credit availability.

6. Discussion

How can our findings be reconciled with theory? To recall, we showed that the risk of late deliveries induces manufacturers to hold more inventories of inputs. The result is quite robust, thus providing convincing evidence for the stockout motive. We also saw

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[38] Additional instruments for overdraft ceiling include: startup year (older firms have had time to build a credit record and should have easier access to credit); ethnicity and ethnicity x sales (African managed firms have fewer business contacts and are thus penalized in access to credit, especially if they are small; see Fafchamps (1998)); corporation dummy (corporations have identifiable assets); subsidiary dummy (subsidiaries get easier access to external finance thanks to the support of their mother company); foreign ownership dummy (firms wholly or partially owned by foreigners are likely to get easier access to international finance). All these variables are reasonable instruments because they are not changed easily as a result of circumstances. Market risk, demand shocks, and contractual risk are included as explanatory variables in the instrumenting equation.

that firms facing more seasonal variation in their sales do not appear to hold larger inventories, hence providing little support for the production smoothing motive. Finally, we found that firms who experience more inter-annual variations in their sales hold less inventories, while firms that face larger than average annual sales hold more stocks. These latter findings are puzzling since they contradict most current theories about inventories. What makes them even more troubling is that the evidence on delayed delivery risk shows that Zimbabwean manufacturers do worry about stocking out. What could account for these results?

One possible explanation is that inter-annual variation in sales is a poor predictor of intra-annual variation. Intuitively, the production smoothing and stockout motives apply more to day-to-day than to year-to-year variations in sales. It would, for instance, be foolish for a garment manufacturer to systematically stock up products today in the hope of selling them a year or two later. This strategy would not only be expensive, especially in economies like Zimbabwe where the cost of funds is high (e.g., Gunning and Mumbengegwi (1995)); it may not even be practical since fashion changes over time. The best strategy might be for this manufacturer to adapt to fluctuations in demand once they have manifested themselves.

If this interpretation is correct, that is, if flexibility, not inventory accumulation, is the primary method by which firms adapt to market risk, then firms facing more inter-annual market risk should remain more flexible and hold less inventories. This is what we find in the data. By the same token, we would expect firms to step up production and build up temporary inventories when markets conditions are favorable. Again, this is what the data suggests.

Further support for this interpretation is found by regressing the rate of capacity utilization on market risk and demand shocks. If firms adapt to unpredictable demand fluctuations by remaining flexible, we would expect firms to hoard excess capacity to deal with demand spikes. As a corollary, we would thus expect market risk to reduce capacity utilization. Regression results presented in Table 14 confirm this interpretation: capacity utilization follows a pattern similar to that of inventories in the sense that firms facing more inter-annual fluctuations in sales have a lower capacity utilization, while facing a positive demand shock increases capacity utilization.

There are, however, other features of our results that do not at first glance conform with this interpretation. If flexibility is the dominant issue, then one would intuitively expect market risk to have a stronger effect on inventory holdings among long recall firms (sales measured over an entire year) than among short recall firms (sales measured over one month). The reason is that flexibility is more critical with respect to long lasting demand shocks, since there is more time to adjust and less being lost as a result of short inventories. Our measure of market risk is more sensitive to short-term demand fluctuations among long recall firms than among short recall firms. Consequently, one would expect long-term market fluctuations to induce more desire for flexibility. Of course, it is possible that manufacturers adjust their production plan and inventory holdings over the short term as well, i.e., from month to month, in which case they would be more sensitive to short-term demand fluctuations. These issues deserve more investigation.

7. Conclusion

The stockout risk motive predicts that firms that face more risk should accumulate more inventories and cash reserves. This paper tested this theory using panel data for manufacturing firms in Zimbabwe. These firms hold large inventories of inputs, several times larger than inventories of goods in progress and finished product. They face substantial contractual risk in the form of late deliveries of inputs and late (or non) payment by clients. Econometric analysis of these survey data shows that contractual risk leads firms to raise their inventories and liquidity reserves and that these effects are strong. Payment risk appears to be highest among firms involved in exports. This suggests that the promotion of manufacturing exports should explicitly take contractual risk into account, especially at the onset of the export drive process (e.g., Fafchamps (1994)).

In contrast to Ramey (1989) and Cuthbertson and Gasparro (1993), our results show that market risk has a negative effect on inventory holdings. We find no evidence that demand seasonality raises manufacturers' inventories, contrary to the production smoothing motive. In addition, we also find that capacity utilization is lower among firms that face more market risk, but that it rises with positive demand shocks. We interpret these results as evidence that flexibility, not inventory accumulation, is the primary method by which Zimbabwe manufacturers adapt to market risk. Because our analysis is not based on direct measures of market risk expectations, however, these conclusions should be regarded as tentative until better data become available.

The literature on the microeconomic performance of firms in developing countries stresses that in a risky environment with poor financial instruments firms respond to risk in ways which are costly in terms of foregone profits and growth (e.g. Collier and Gunning (1998)). Previous work on responses of African firms to risk has shown that concerns with contractual compliance lead to the emergence of business networks and, perhaps, statistical discrimination (e.g., Fafchamps (1998, 1997)). Restricting transactions to small networks suitable for contract enforcement is costly in terms the collection of business information (Barr (1996)). Our results complement this research by showing that contractual risk is also costly by inducing firms to invest on a large scale in inventories of inputs.

Much of the contractual risk faced by African firms reflects the inability (rather than the unwillingness) of contract partners to comply. In part this is due to poor infrastructure and oligopolistic market structures. These conditions are changing under structural adjustment programs. Our result are consistent with respondents' assertions that one of the side benefits on structural adjustment was to improve input availability and to enable manufacturers to reduce their inventories of inputs.

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Table 1. Summary of Model Predictions

	Production smoothing motive		Stockout motive	
Effect on inventories of:	*Inputs*	*Output*	*Inputs*	*Output*
Market risk	No	Yes	Yes	Yes
Delivery risk	No	No	Yes	No
Seasonal variation	No	Yes	No	No

Table 2. Summary Statistics

	Nber of observ.	Percentage of sample firms			
Food processing	609	23%			
Textile	609	14%			
Garment	609	27%			
Metal products	609	18%			
Wood products	609	13%			
Leather	609	5%			
in Harare	606	46%			
in Bulaweyo	606	27%			
in another location	606	16%			
Ethnic African owner/manager	600	32%			
Ethnic European owner/manager	600	51%			
Other ethnicity	600	17%			
With an overdraft facility	580	66%			
With a savings account	577	46%			
	Nber of observ.	**Sample Mean**	**Percentiles** 5%	Median	95%
Total sales	901	13751	9	2216	60219
Total capital	900	14945	2	1110	66312
Total employment	951	298	4	90	1358
Inventory of inputs	539	1503	0	193	6014
Inventory of goods in progress	457	420	0	29	2265
Inventory of finished products	494	823	0	41	4202
Account payable (supplier credit)	566	1249	0	88	6543
Overdraft ceiling	389	1077	0	55	7151
Overdraft balance	572	702	0	0	5400
Unused overdraft	387	440	0	0	2398
No. of delayed deliveries per year	188	21	0	1	100
No. of deficient quality deliveries per year	193	7	0	1	43
No. of delayed payments per year	178	90	0	10	303
No. of non-payments per year	187	6	0	1	33
Coefficient of variation of annual sales	901	34%	8%	28%	83%

All values are given in '000 Zimbabwean dollars in constant 1990 terms. One US$ is approximately equivalen to 8 Zimbabwean dollars. Number of observations varies due to missing values and differences in questionnaires between rounds. 1991 and 1992 data on total sales, total capital, and total employment come from retrospective questions.

Table 3. Inventories and Delayed Delivery Risk
All results are based on censored least absolute deviations (CLAD) regressions.
Standard errors are obtained using bootstrapping with 100 replications.

	Inputs		**Goods in progress**		**Finished products**		**Total inventories**	
(Pseudo) R-squared	0.117		0.047		0.045		0.138	
	Coef.	t-stat.	Coef.	t-stat.	Coef.	t-stat.	Coef.	t-stat.
Log of incidence of delayed deliveries	0.016	**6.063**	0.003	**2.999**	0.003	**1.714**	0.022	**4.594**
Predicted sales	0.000	**2.230**	0.000	**2.805**	0.000	**1.988**	0.000	**1.862**
Food sector dummy	-0.066	**-4.465**	-0.036	**-3.229**	-0.027	**-4.083**	-0.153	**-8.626**
Wood and furniture sector dummy	-0.034	**-2.056**	-0.005	-0.766	-0.022	**-3.465**	-0.097	**-4.400**
Textile sector dummy	-0.029	-1.216	-0.002	-0.282	-0.001	-0.088	-0.037	-1.229
Metal sector dummy	-0.015	-0.818	0.003	0.412	-0.023	**-3.033**	-0.065	**-2.387**
Leather sector dummy	0.056	**1.929**	0.009	**1.903**	-0.011	-0.591	0.014	0.486
Dummy for 1994	-0.007	-0.790	0.005	1.184	0.001	0.203	-0.007	-0.440
Dummy for 1995	-0.042	**-3.812**	-0.012	**-2.719**	-0.009	**-1.916**	-0.053	**-3.032**
Intercept	0.085	**5.140**	0.014	**2.773**	0.032	**5.038**	0.192	**9.774**
Number of observations	507		507		507		507	
Number of zero observations	79		191		138		54	
Number of positive observations	428		316		369		453	

Table 4. Credit, Liquidity, and Contractual Risk

All results are based on censored least absolute deviations (CLAD) regressions.
Standard errors are obtained using bootstrapping with 100 replications.

	Overdraft Credit		**Supplier Credit**		**Overdraft Ceiling**		**Overdraft Reserve**	
(Pseudo) R-squared	0.049		0.102		0.095			
	Coef.	t-stat.	Coef.	t-stat.	Coef.	t-stat.	Coef.	t-stat.
Log of incidence of delayed deliveries	0.013	**2.458**	0.014	**5.774**	0.020	**4.735**	0.008	**2.568**
Log of incidence of delayed payments	0.014	**2.448**	0.009	**3.547**	0.009	**2.066**	0.002	1.151
Predicted sales	-0.000	-0.206	0.000	**1.775**	0.000	0.082	0.000	0.120
Food sector dummy	-0.030	-1.360	0.010	1.093	-0.021	-1.064	0.002	0.246
Wood and furniture sector dummy	-0.022	-1.436	0.002	0.194	-0.032	-1.357	-0.003	-0.331
Textile sector dummy	-0.021	-0.773	-0.012	-0.871	-0.036	-0.836	0.002	0.136
Metal sector dummy	-0.007	-0.331	0.005	0.662	-0.013	-0.623	-0.004	-0.316
Leather sector dummy	-0.006	-0.126	-0.008	-0.371	0.079	**1.882**	0.010	1.112
Dummy for 1994	-0.004	-0.317	0.012	1.498	n.a.		n.a.	
Dummy for 1995	-0.011	-0.884	0.012	1.639	-0.008	-0.912	-0.006	-1.297
Intercept	-0.032	-1.149	-0.014	-1.454	0.006	0.373	-0.007	-0.787
Number of observations	474		473		314		312	
Number of zero observations	249		103		111		154	
Number of positive observations	225		370		203		158	

Note: questions about overdraft ceiling were asked in 1994 and 1995 only.

Table 5. Determinants of Contractual Risk

All results are based on censored least absolute deviations (CLAD) regressions.
Standard errors are obtained using bootstrapping with 100 replications.

	Delayed deliveries by suppliers		*Delayed payment by clients*	
Pseudo R-squared	0.098		0.175	
1. Common variables	Coef.	t-stat.	Coef.	t-stat.
Predicted sales	0.000	0.011	0.000	1.355
Food sector dummy	0.434	0.703	-1.246	**-1.901**
Wood and furniture sector dummy	0.433	0.549	-0.452	-0.720
Textile sector dummy	-0.640	-1.229	-1.079	-1.616
Metal sector dummy	-0.825	-1.524	-0.425	-0.667
Leather sector dummy	-1.010	-1.166	-0.109	-0.179
2. Instruments				
Startup year	-0.029	**-2.386**	-0.013	-0.919
Share of inputs that are imported	0.009	0.967		
Share of main input from main supplie	-0.013	-1.560		
Share of output that is exported			0.004	0.319
Exporter dummy (yes=1)			1.120	**2.304**
Located in Bulawayo	-0.168	-0.427	0.256	0.484
Located in small town	-1.184	-1.589	-0.146	-0.264
Intercept	58.951	**2.481**	26.745	0.995
Selection-term				
Number of observations	165		173	
Number of zero observations	73		35	
Number of positive observations	92		138	

Table 6. Inventories and Delayed Delivery Risk, Instrumented

All results are based on censored least absolute deviations (CLAD) regressions.
Standard errors are obtained using bootstrapping with 100 replications.

	Inputs		**Goods in progress**		**Finished products**		**Total inventories**	
(Pseudo) R-squared	0.123		0.058		0.044		0.128	
	Coef.	t-stat.	Coef.	t-stat.	Coef.	t-stat.	Coef.	t-stat.
Predicted incidence of late deliveries	0.058	**7.488**	0.008	**2.671**	0.003	0.952	0.045	**4.329**
Predicted sales	-0.000	-1.142	0.000	**3.640**	0.000	**2.135**	0.000	0.227
Food sector dummy	-0.078	**-5.236**	-0.104	**-3.528**	-0.033	**-6.478**	-0.167	**-8.104**
Wood and furniture sector dummy	-0.039	**-2.464**	-0.003	-0.413	-0.024	**-3.655**	-0.107	**-4.895**
Textile sector dummy	0.015	0.717	-0.004	-0.643	-0.009	-0.818	-0.036	-0.951
Metal sector dummy	0.030	1.557	0.011	**1.755**	-0.020	**-2.516**	-0.036	-1.301
Leather sector dummy	0.059	**2.617**	0.006	1.320	-0.009	-0.489	0.003	0.115
Dummy for 1994	-0.009	-0.847	0.003	0.592	0.000	0.061	-0.005	-0.308
Dummy for 1995	-0.016	-1.230	-0.001	-0.173	-0.001	-0.178	-0.030	**-1.694**
Intercept	0.043	**2.469**	0.007	1.471	0.033	**5.893**	0.179	**7.511**
Number of observations	494		494		494		494	
Number of zero observations	55		177		127		32	
Number of positive observations	439		317		367		462	

Table 7. Credit, Liquidity, and Contractual Risk, Instrumented
All results are based on censored least absolute deviations (CLAD) regressions.
Standard errors are obtained using bootstrapping with 100 replications.

	Overdraft Credit		**Supplier Credit**		**Overdraft Ceiling**		**Overdraft Reserve**	
(Pseudo) R-squared	0.044		0.074		0.092			
	Coef.	t-stat.	Coef.	t-stat.	Coef.	t-stat.	Coef.	t-stat.
Log of incidence of delayed deliveries	-0.005	-0.434	0.010	**1.943**	0.021	1.248	0.002	0.547
Log of incidence of delayed payments	0.043	**3.166**	0.023	**4.050**	0.044	**3.576**	0.018	**2.683**
Predicted sales	-0.000	**-1.966**	-0.000	-0.703	-0.000	**-2.691**	-0.000	-1.594
Food sector dummy	0.012	0.760	0.032	**2.771**	0.037	1.509	0.023	**2.073**
Wood and furniture sector dummy	-0.047	-1.275	-0.008	-0.737	-0.070	**-2.940**	-0.011	-0.928
Textile sector dummy	-0.018	-0.861	0.007	0.675	-0.002	-0.058	-0.001	-0.081
Metal sector dummy	-0.036	-1.731	0.007	0.600	-0.012	-0.448	-0.016	-1.147
Leather sector dummy	-0.016	-0.400	0.010	0.620	0.070	**1.970**	-0.015	-1.328
Dummy for 1994	-0.001	-0.040	0.024	**2.616**	n.a.		n.a.	
Dummy for 1995	-0.010	-0.811	0.020	**2.320**	-0.005	-0.401	0.005	0.915
Intercept	-0.074	**-2.199**	-0.045	**-3.361**	-0.076	**-2.099**	-0.039	**-2.135**
Number of observations	492		489		323		321	
Number of zero observations	256		103		113		158	
Number of positive observations	236		386		210		163	

Note: questions about overdraft ceiling were asked in 1994 and 1995 only.

Table 8. Inventories, Market Risk, and Delayed Delivery Risk
All results are based on censored least absolute deviations (CLAD) regressions.
Standard errors are obtained using bootstrapping with 100 replications.

	Inputs		**Goods in progress**		**Finished products**		**Total inventories**	
(Pseudo) R-squared	0.150		0.064		0.060		0.180	
	Coef.	t	Coef.	t	Coef.	t	Coef.	t
CV of sales for long recall firms	-0.031	-1.155	-0.029	**-3.583**	-0.026	**-1.736**	-0.046	-1.243
CV of sales for short recall firms	-0.215	**-5.919**	-0.038	**-4.810**	-0.054	**-3.634**	-0.282	**-5.509**
Sales shock	0.015	0.643	0.006	1.108	0.007	0.590	0.069	**2.708**
Log of incidence of delayed deliveries	0.011	**5.352**	0.002	**1.690**	0.001	0.678	0.016	**3.877**
Predicted sales	0.000	**2.237**	0.000	**3.597**	0.000	**1.285**	0.000	**2.112**
Food sector dummy	-0.082	**-6.414**	-0.038	**-6.406**	-0.032	**-4.958**	-0.170	**-9.884**
Wood and furniture sector dummy	-0.029	**-1.982**	-0.003	-0.444	-0.024	**-3.625**	-0.074	**-3.679**
Textile sector dummy	-0.026	-1.361	-0.001	-0.107	0.008	0.745	-0.017	-0.639
Metal sector dummy	-0.020	-1.185	-0.001	-0.092	-0.023	**-3.268**	-0.051	**-2.094**
Leather sector dummy	0.045	1.538	-0.001	-0.218	-0.006	-0.229	0.013	0.462
Dummy for 1994	-0.011	-0.991	0.003	0.796	0.001	0.252	-0.017	-0.952
Dummy for 1995	-0.024	**-1.954**	-0.004	-0.899	-0.006	-1.181	-0.051	**-3.297**
Intercept	0.121	**6.535**	0.031	**5.039**	0.048	**6.536**	0.239	**11.357**
Number of observations	484		484		484		484	
Number of zero observations	46		169		116		35	
Number of positive observations	432		315		368		449	

Table 9. Inventories, Market Risk, and Delayed Delivery Risk
All results are based on censored least absolute deviations (CLAD) regressions.
Standard errors are obtained using bootstrapping with 100 replications.

	Inputs		**Goods in progress**		**Finished products**		**Total inventories**	
(Pseudo) R-squared	0.138		0.047		0.066		0.177	
	Coef.	t	Coef.	t	Coef.	t	Coef.	t
CV of sales for long recall firms	-0.039	-0.853	-0.015	-0.673	0.022	1.048	-0.012	-0.183
CV of sales for short recall firms	-0.376	**-5.350**	-0.027	**-1.826**	-0.078	**-2.825**	-0.280	**-6.127**
Firm specific sales trend	0.076	**2.367**	0.007	0.456	0.057	**3.780**	0.174	**3.823**
Sales shock	0.025	0.953	-0.001	-0.140	-0.001	-0.146	-0.009	-0.290
Log of incidence of delayed deliveries	0.010	**3.341**	0.002	1.243	0.002	1.102	0.018	**4.308**
Predicted sales	0.000	**1.742**	0.000	**2.634**	0.000	1.495	0.000	**2.428**
Food sector dummy	-0.095	**-6.602**	-0.061	**-3.182**	-0.028	**-3.404**	-0.174	**-7.594**
Wood and furniture sector dummy	-0.052	**-2.664**	-0.003	-0.613	-0.033	**-4.684**	-0.090	**-3.741**
Textile sector dummy	-0.018	-0.849	-0.005	-0.677	0.010	0.961	-0.032	-1.191
Metal sector dummy	-0.029	**-1.987**	0.003	0.508	-0.017	**-2.242**	-0.049	**-1.976**
Leather sector dummy	0.042	1.616	0.002	0.288	-0.006	-0.212	0.006	0.195
Dummy for 1994	-0.015	-1.474	0.004	0.787	-0.001	-0.245	-0.019	-1.359
Dummy for 1995	-0.038	**-3.326**	-0.002	-0.304	-0.004	-1.000	-0.046	**-3.181**
Intercept	0.138	**7.619**	0.021	**2.660**	0.037	**3.668**	0.234	**8.515**
Number of observations	484		484		484		484	
Number of zero observations	46		169		116		35	
Number of positive observations	432		315		368		449	

Table 10. Inventories, Market Risk, and Delayed Delivery Risk, Instrumented
All results are based on censored least absolute deviations (CLAD) regressions.
Standard errors are obtained using bootstrapping with 100 replications.

	Inputs		**Goods in progress**		**Finished products**		**Total inventories**	
(Pseudo) R-squared	0.135		0.061		0.042		0.136	
	Coef.	t-stat.	Coef.	t-stat.	Coef.	t-stat.	Coef.	t-stat.
Predicted CV of sales	-0.644	**-4.257**	-0.073	-1.044	-0.183	**-1.926**	-0.646	**-3.310**
Sales shock	0.018	1.072	0.009	1.326	0.019	**1.838**	0.073	**2.534**
Predicted delivery risk	0.053	**6.299**	0.009	**2.435**	0.002	0.619	0.049	**4.391**
Predicted sales	-0.000	**-4.141**	0.000	**2.081**	0.000	0.650	-0.000	-0.875
Food sector dummy	-0.083	**-6.231**	-0.098	**-2.489**	-0.033	**-4.264**	-0.183	**-9.211**
Wood and furniture sector dummy	-0.021	-1.163	-0.001	-0.135	-0.017	**-1.674**	-0.097	**-5.120**
Textile sector dummy	0.008	0.434	-0.002	-0.262	-0.001	-0.109	-0.037	-1.188
Metal sector dummy	0.005	0.352	0.008	1.095	-0.029	**-3.393**	-0.050	**-1.799**
Leather sector dummy	0.027	0.964	-0.000	-0.035	-0.013	-0.532	-0.007	-0.211
Dummy for 1994	-0.001	-0.099	0.007	1.642	0.000	0.003	-0.008	-0.587
Dummy for 1995	-0.012	-0.983	-0.000	-0.052	-0.003	-0.508	-0.039	**-2.662**
Intercept	0.287	**5.018**	0.035	1.212	0.106	**2.859**	0.422	**5.659**
Number of observations	481		481		481		481	
Number of zero observations	48		167		117		25	
Number of positive observations	433		314		364		456	

Table 11. Credit, Liquidity, and Contractual Risk

All results are based on censored least absolute deviations (CLAD) regressions.
Standard errors are obtained using bootstrapping with 100 replications.

	Overdraft Credit		**Supplier Credit**		**Overdraft Ceiling**		**Overdraft Reserve**	
(Pseudo) R-squared	0.103		0.091		0.107		0.053	
	Coef.	t	Coef.	t	Coef.	t	Coef.	t
CV of sales for long recall firms	-0.113	**-2.468**	-0.045	**-2.315**	-0.025	-0.616	-0.002	-0.080
CV of sales for short recall firms	-0.092	-1.628	-0.169	**-2.641**	-0.284	-0.928	-0.039	-1.119
Sales shock	0.017	0.369	0.024	**1.990**	0.048	1.587	0.016	1.219
Log of incidence of delayed deliveries	0.023	**2.825**	0.008	**3.324**	0.014	**4.359**	0.007	**2.915**
Log of incidence of delayed payments	0.022	**4.008**	0.008	**4.427**	0.011	**2.540**	0.002	0.882
Predicted sales	0.000	0.487	0.000	1.158	-0.000	-0.492	-0.000	-0.355
Food sector dummy	-0.080	**-2.195**	-0.002	-0.153	-0.023	-1.060	0.004	0.450
Wood and furniture sector dummy	-0.059	**-2.562**	-0.001	-0.045	-0.036	**-1.760**	-0.002	-0.165
Textile sector dummy	-0.139	**-3.161**	-0.020	-1.226	-0.058	**-1.997**	-0.002	-0.171
Metal sector dummy	-0.022	-0.958	-0.011	-0.921	-0.017	-0.877	-0.006	-0.602
Leather sector dummy	0.020	0.499	-0.003	-0.154	0.063	1.384	0.015	0.936
Dummy for 1994	0.004	0.266	0.027	**3.486**	n.a.		n.a.	
Dummy for 1995	0.008	0.511	0.019	**1.919**	-0.018	**-1.680**	-0.002	-0.472
Intercept	-0.044	**-1.770**	0.016	1.184	0.046	**1.919**	0.000	0.003
Number of observations	453		453		314		293	
Number of zero observations	237		99		111		142	
Number of positive observations	216		354		203		151	

Note: questions about overdraft ceiling were asked in 1994 and 1995 only.

Table 12. Credit, Inventories, Market Risk, and Delayed Delivery Risk
All results are based on censored least absolute deviations (CLAD) regressions.
Standard errors are obtained using bootstrapping with 100 replications.

	Inputs		**Goods in progress**		**Finished products**		**Total inventories**	
(Pseudo) R-squared	0.166		0.068		0.089		0.198	
	Coef.	t	Coef.	t	Coef.	t	Coef.	t
Overdraf ceiling	0.170	**2.744**	0.063	**3.187**	0.085	**2.902**	0.197	**2.366**
CV of sales for long recall firms	-0.039	-1.213	-0.025	-1.210	0.001	0.062	-0.027	-0.537
CV of sales for short recall firms	-0.163	**-3.729**	-0.048	**-1.692**	-0.016	-0.891	-0.182	**-3.669**
Sales shock	0.015	0.534	0.010	0.948	0.033	**2.274**	0.093	**2.729**
Log of incidence of delayed deliveries	0.009	**2.607**	-0.002	-1.401	0.001	0.332	0.012	**2.752**
Predicted sales	0.000	**1.875**	0.000	**3.168**	0.000	1.145	0.000	**2.988**
Food sector dummy	-0.069	**-4.589**	-0.061	**-4.553**	-0.028	**-2.702**	-0.151	**-6.474**
Wood and furniture sector dummy	-0.017	-0.983	0.003	0.435	-0.024	**-2.231**	-0.069	**-2.818**
Textile sector dummy	-0.011	-0.451	0.005	0.515	0.013	0.946	-0.050	-1.511
Metal sector dummy	-0.006	-0.331	-0.005	-0.652	-0.017	-1.329	-0.040	-1.370
Leather sector dummy	0.033	1.344	-0.004	-0.575	-0.011	-0.315	-0.022	-1.020
Dummy for 1995	-0.016	**-1.725**	-0.005	-0.999	-0.007	-1.112	-0.031	**-2.237**
Intercept	0.088	**4.684**	0.031	**2.828**	0.033	**2.362**	0.198	**6.774**
Number of observations	311		311		311		311	
Number of zero observations	48		106		74		27	
Number of positive observations	263		205		237		284	

Table 13. Credit, Inventories, Market Risk, and Delayed Delivery Risk, Instrumented
All results are based on censored least absolute deviations (CLAD) regressions.
Standard errors are obtained using bootstrapping with 100 replications.

	Inputs		**Goods in progress**		**Finished products**		**Total inventories**	
(Pseudo) R-squared	0.184		0.069		0.072		0.178	
	Coef.	t	Coef.	t	Coef.	t	Coef.	t
Predicted overdraft ceiling	0.627	**3.982**	0.074	1.422	0.278	**3.136**	1.093	**5.095**
Predicted CV of sales	-0.297	**-2.171**	-0.052	-0.658	-0.106	-1.049	-0.545	**-2.287**
Sales shock	0.014	1.060	0.010	1.169	0.006	0.625	0.064	**1.936**
Predicted delivery risk	0.030	**3.031**	0.005	1.147	-0.005	-1.116	0.018	1.420
Predicted sales	-0.000	-0.775	0.000	**2.154**	0.000	1.141	0.000	0.004
Food sector dummy	-0.061	**-4.624**	-0.084	**-2.448**	-0.023	**-2.832**	-0.148	**-6.807**
Wood and furniture sector dummy	-0.001	-0.036	0.003	0.361	-0.001	-0.133	-0.029	-0.966
Textile sector dummy	0.003	0.175	-0.001	-0.077	-0.001	-0.117	-0.033	-1.197
Metal sector dummy	0.011	0.580	0.005	0.611	-0.017	**-1.670**	-0.015	-0.617
Leather sector dummy	-0.015	-0.548	-0.002	-0.156	-0.026	-0.897	-0.104	**-2.485**
Dummy for 1994	-0.003	-0.306	0.002	0.392	-0.005	-0.793	-0.001	-0.073
Dummy for 1995	-0.014	-1.339	-0.001	-0.272	-0.005	-0.733	-0.016	-0.872
Intercept	0.143	**2.457**	0.027	0.846	0.065	**1.615**	0.323	**3.314**
Number of observations	413		413		413		413	
Number of zero observations	42		144		97		21	
Number of positive observations	371		269		316		392	

Table 14. Capacity Utilization and Market Risk

All results are based on censored least absolute deviations (CLAD) regressions.
Standard errors are obtained using bootstrapping with 100 replications.

(Pseudo) R-squared	0.058	
	Coef.	t
CV of sales for long recall firms	-0.016	-0.182
CV of sales for short recall firms	-0.221	**-2.136**
Sales shock	0.120	**2.192**
Predicted sales	0.000	1.039
Food sector dummy	-0.164	**-3.268**
Wood and furniture sector dummy	-0.032	-0.795
Textile sector dummy	-0.071	-1.537
Metal sector dummy	-0.121	**-3.708**
Leather sector dummy	-0.089	-1.070
Dummy for 1994	0.092	**2.979**
Dummy for 1995	0.053	1.410
Intercept	0.732	**18.156**
Number of observations	523	
Number of zero observations	90	
Number of positive observations	433	