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Trade Credit and Productive Efficiency in Developing Countries

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Summary. — In developing countries, credit shortages are often so severe as to impact a firm's day-to-day production decisions. Using firm-level data from five African countries, I show supplier credit is positively correlated with capacity utilization; the result continues to hold when credit access is instrumented using supplier characteristics. I claim that this is because firms lacking credit likely face inventory shortages, leading to lower rates of capacity utilization. This explanation yields several further predictions that are supported by the data: there is a positive relationship between supplier credit and inventory holdings; moreover, raw materials "stockouts" are positively correlated with capacity utilization, particularly in "inventory-intensive" industries. © 2001 Elsevier Science Ltd. All rights reserved.

Key words — sub-Saharan Africa, credit markets, production smoothing, inventory management

1. INTRODUCTION

Trade credit is an important form of financing for businesses in a broad range of industries and economies. Even in the United States, with its extremely well-developed financial markets, trade credit is the largest single source of short-term financing (Petersen & Rajan, 1997). In less-developed countries, where formal lenders are scarce at best, trade credit plays an even more significant role in funding firms' activities.

Given the prevalence and importance of trade credit, it is not surprising that there already exists an extensive literature on many aspects of credit relationships. The fundamental question addressed by this body of work is why suppliers may be better positioned than specialized banking institutions to lend money to their customers. Theories of trade credit abound, and have been examined empirically in a wide range of circumstances. Commonly cited explanations include the importance of linking credit transactions to those in product markets, informational issues, and price discrimination. The most comprehensive attempt to differentiate among these explanations comes from Petersen and Rajan (1997), who look at the determinants of trade credit for a sample of (relatively) small US firms. In the context of developing countries, the determinants of trade credit have also been examined in detail on every continent. [1] Clearly, it is worthwhile to develop a better understanding of who gets trade credit, and why it might be preferred to bank financing. One gap in this work, however, is the issue of why trade credit is so important in the first place. Its ubiquity suggests that it plays an important role in firm financing, but efforts to assess how big an effect it has on the "real" side of the economy have been extremely limited. To turn the question around, what are the costs of being shut out of trade credit relationships? Furthermore, what are the mechanisms through which trade credit affects the "real" side of the economy? Finally, given that credit matters, can we say anything about where access to trade credit will matter the most?

In this paper, I make an initial attempt to examine these issues in the context of African manufacturing. My basic claim is that trade credit, to a large degree, obviates the need to have cash on hand to purchase raw material inputs. Thus, firms with supplier credit access will not have to wait to process and sell their products before purchasing new inputs, and starting the production cycle once more. In other words, such firms will be less prone to raw material shortages, and will be less likely to be affected by the associated interruptions in production. Thus, firms with supplier credit will

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be better able to efficiently manage inventories and will therefore be less exposed to costly stoppages and delays in production, i.e., firms with access to credit should have higher rates of capacity utilization.

I provide evidence for this basic hypothesis from a cross-section of African firms in Côte d' Ivoire, Kenya, Tanzania, Zambia, and Zimbabwe. I find that the effect of supplier credit on capacity utilization is positive, large (about 10%), and statistically significant. The size of this effect is marginally increased when credit access is instrumented for using length of supplier relationship, though the significance of the effect is reduced. In terms of the mechanism by which supplier credit affects capacity utilization, I find that supplier credit access has a much greater effect on capacity utilization in inventory-intensive industries, thereby providing some evidence that the impact of credit access acts primarily through its effect on inventory control.

Furthermore, I find that firms with supplier credit are far less likely to have raw materials "stockouts," and that firms facing "stockouts" have lower rates of capacity utilization. All of the results are much stronger among firms that claim to face some credit constraints, which are precisely the types of firms that would be most affected by the inventory control problems described above.

The rest of this paper is structured as follows: Section 1 will further elaborate on the theory of how trade credit affects capacity utilization, and why we might expect these effects to be particularly strong in developing economies. In Section 2, I describe the data that were used for this project. The results, along with their interpretation, are presented in Section 3. Section 4 concludes the paper.

2. FINANCE, INVENTORIES AND CAPACITY UTILIZATION

Models of inventory management have usually ignored the effects of credit constraints, treating inventory levels as a choice variable in an "unconstrained" optimal control problem. For the purposes of this paper, the crucial assumption is that the cost of raw materials to produce output of q, is given by $C(q) = K + c(q)$, where $K > 0$, and $c(\cdot)$ is usually assumed to be linear. This functional form is used by both economists and operations management scholars, and is consistent with industry conventional wisdom. The intuition is that there is some fixed cost for the delivery of inputs—a truck must visit the plant; a messenger needs to be sent with the new order. This means that the firm cannot continuously order small amounts of each input. With a number of other fairly unrestrictive assumptions, these models lead to so-called (S, s) rules for inventory management, under which a firm replenishes its inventories to a level S after inventories have dropped below s. In a model where demand is known, the problem is deterministic, and reduced to one of choosing the optimal S^*, with $s = 0$ (there is no need to keep inventories in reserve for unexpected shocks). Obviously, all else equal, a higher fixed cost K will result in a higher S^*, since on the margin, it will be desirable to make less frequent raw material purchases.

The addition of lags in production, the sale of finished products, and the ordering of raw materials to the model is relatively straightforward. For example, if there is a lag of t_0 "days" between ordering new inputs and their arrival at the factory, new orders will be placed t_0 days before inventories are due to run out; production time and time to sale do not affect the model at all. The qualitative effect of adding a stochastic component to demand and/or delivery times is also relatively clear: the firm will be required to keep a "buffer stock" of inventories on hand to deal with unexpected shocks.

One important element of the above description is that, to a large degree, the optimal (S, s) rule will depend on firm-specific circumstances: a low level of inventories may not be a sign of poor inventory management; rather, it may simply result from some combination of firm-specific factors such as low fixed ordering costs, rapid and reliable product delivery, and stable supply/demand.

When financing constraints are introduced, the model becomes much more complex. The complications arise from the fact that, if a firm has a shortage of financial capital, it may not have sufficient funds to bring its level of inventories back up to S^* when its inventories fall below s^*. The firm then faces a tradeoff: it may reorder early, using a restocking rule with $S^C < S^*$; or it may wait, letting stocks fall below s^* before reordering. In general, it will choose an "internal" solution, trading off the cost of waiting (in terms of lost output) against the cost of making a smaller than optimal order (and thus paying a higher fixed cost per unit of input). If there is a long lag between the

purchase of inputs and the sale of output, the firm will end up sitting idle for a time, waiting for enough funds to accumulate to purchase new raw materials. If volatility in demand and/or delivery is the reason that the firm does not want its stocks to fall below s^*, then letting inventories drop below this level will leave the firm exposed to costly inventory stockouts resulting from unusually high demand or the delayed delivery of inputs.In either case, the credit-constrained firm will, in expectation, sit idle for some time while it waits for additional funds to collect from the sale of finished goods.

The basic point is quite intuitive: firms without access to liquidity face barriers to the optimal handling of working capital, leading to inventory shortages, and resulting in discontinuities and inefficiencies in production. Thus, the model predicts a positive relationship between access to funds and capacity utilization. Furthermore, the model implies that this relationship results from a positive relationship between access to funds and inventories, and a further positive relationship between inventory holdings and capacity utilization.

While the above model applies equally well to liquidity access generally speaking, I focus on trade credit because it has so often been cited for its importance in bridge financing for firms in developing countries. The lack of development in financial markets, and the general shortage of financial capital, means that financial constraints are likely to loom large in a firm's production decisions, and that there will be relatively few viable alternatives to trade credit. In the econometric results, I will include other forms of financing as controls, and will discuss further at that point why I expect other sources of funds to be less important than trade credit.

There are a number of further characteristics of developing economies that motivate firms to hold relatively high inventories, and this is likely to exacerbate the effects of credit shortages. Most prevalent among these concerns is risk. The effect of risk on motivations to hold inventories has been carefully analyzed by Fafchamps, Gunning, and Oostendorp (2000) in their study of the inventory holdings of Zimbabwean firms; they find that risk of delayed deliveries explains much of the inventory behavior of manufacturing firms. As they point out, risks of this kind are more likely to be severe in less developed economies. [2]

3. DATA

The data used in this paper come from the surveys administered by the Regional Program on Enterprise Development (RPED) at the World Bank. [3] These surveys were administered to owners and managers at a (size-weighted) random sample of firms in seven African countries, including Cameroon, Côte d'Ivoire, Ghana, Kenya, Tanzania, Zambia, and Zimbabwe during 1992–95. Three rounds of the survey were conducted in each country; where possible, the same firms were visited in each round. For this paper, I use primarily the results of the first round of interviews from Côte d'Ivoire, Kenya, Tanzania, Zambia, and Zimbabwe. Cameroon and Ghana were dropped because their surveys did not include data on inventories. I do not utilize later rounds of the survey, because very few data on credit access were collected after the first round.

The survey instrument covered a wide variety of topics including: basic statistics on the firms' sales and expenditures, background/ historical information on the firms and their owners; use of technology; competition and competitors (only in the later rounds); labor; financing and contractual relations; conflict resolution; regulation; infrastructure; and use of business support services.

The basic relationships to be analyzed in this paper are:

$$\text{Capacity utilization} = f(\text{credit access}).$$

Taking into account the intermediate role of inventories, I also consider:

$$\text{Inventories} = f(\text{credit access}).$$

Hence, I require variables to measure capacity utilization, inventory levels, and access to credit.

My measure of capacity utilization (CU) is inferred from the question (or a similar one): "How much more could you produce compared to now with existing equipment?" If the answer to this question is x, then the implied rate of capacity utilization is given by $10\,000/(100 + x)$.

To obtain a measure of credit access, I utilize the following survey question, which was asked with regard to each of the firm's primary three suppliers: "What is the dominant form of payment required by this supplier?" The variable that I use to measure trade credit access (CREDIT) is the proportion of suppliers for

which the firm responded that the dominant form of payment was supplier credit.

In some ways, a more natural measure of "supplier credit intensiveness" would be the ratio of accounts payable to total raw material purchases. Unfortunately, this requires the use of accounting data on sales, which results in an incredibly noisy measure of supplier credit access. Moreover, this measure of credit intensiveness is more seriously affected by problems of causality in the regressions that follow. For example, a firm that is inactive (and hence has a low capacity utilization) will not have credit pending, thus yielding a positive relationship between accounts payable and capacity utilization. Similarly, a firm with inventories on hand will obviously be more likely to have credit pending. Petersen and Rajan (1997) claim that, in their sample of US companies, demand for credit is not be a binding constraint; hence, they assume that any absence of credit results from supply-side rationing. In the context of Africa, with its relatively underdeveloped credit markets, this assumption may be plausible, and is certainly more realistic than the conditions faced by Petersen and Rajan's firms. Under this assumption, CREDIT will be an appropriate measure of credit *access*. [4]

Obviously, this does not fully address concerns of endogeneity. For example, consider a firm that experiences a positive demand shock. This firm will produce more, thereby increasing capacity utilization. At the same time, in order to increase production, the firm orders more inputs, and in the process, accumulates more inventories, which also potentially increases the use of supplier credit. This entirely plausible story could alone account for a positive relationship between supplier credit and capacity utilization, and also for a positive relationship between inventories and capacity utilization. So, it will also be important to instrument appropriately for credit access, which I do in Section 3 below. I do so using length of supplier relationship (LENGTH), and whether the upstream market is competitive (COMPETITION).

A separate issue is what is meant by "supplier credit." If suppliers simply ship goods without demanding cash in advance, but required quick payment (i.e., they trust the buyer to pay within a few days' grace period), then credit is simply a way of facilitating transactions and is irrelevant to the argument outlined in the previous section. But, if suppliers are willing to wait a substantial amount of time for repayment, then this will potentially facilitate production smoothing.

The data provide some insight into this question: for each firm that reported having at least one purchase on credit, the manager was asked a number of questions about the most recent credit transaction. This included a question on the terms of repayment. The modal (and median) repayment period was 30 days; this suggests that credit is more than just a means of facilitating transactions.

My basic measure of inventory rates (INVDUM), a dummy variable that takes on a value of one if the firm has positive inventories on hand. The reason that I use this, rather than a continuous inventory measure, is that the effect that I am primarily interested in has to do with "stockouts," where the firm actually runs out of raw materials. In fact, having relatively low rates of inventories on hand could actually be a sign of efficient inventory management; thus, a dummy variable for raw material inventories is the most appropriate measure. [5] To measure the inventory requirements of different industries and locations, I calculate for each firm its inventory rate (INVENT), which is given by (Raw Materials Inventories at End of Period)/(Annual Sales). [6] This was then used to calculate an industry-country average (AVINV), reflecting firms' "underlying" inventory requirements.

As previously mentioned, the arguments I have described in the above section also apply to other forms of financing. Hence, it will be important to include variables to capture the firm's access to other sources of funds. These include whether the firm has received a bank loan in the last year (LOAN); access to overdraft facilities (OVERD); and whether the firm has money deposited at a bank (DEP).

The preceding variables capture primarily supply-side credit issues. To address the firm's *demand* for credit, I make use of the following question in the survey: "How serious an impediment is lack of credit to the expansion of your business?" This variable (LACCR) was scaled to take on values between zero (least constrained) and one.

In addition, I wish to include variables to proxy for firm quality. My primary control in this regard is firm size, which I measure using total employment (WORKERS)—Following on previous work using the RPED data, I measure this using (full-time workers) + 0.5 $*$ (part-time workers). [7] The analyses in this paper use only observations from firms with 10 or more workers, since the data from smaller firms are considered to be less reliable.

The case for dropping these firms goes much deeper in the particular case that I am examining here. First of all, very few small firms receive supplier credit (a total of 7% of suppliers, *versus* 35% for larger firms), so there may not enough variation to identify an effect. Moreover, it is unclear that the notion of capacity utilization has much meaning for these micro-enterprises. Note that the definition of capacity utilization below is given in terms of utilization of *equipment*. In small African manufacturing firms, much of production is done manually—the notion of capacity utilization used here is not well-defined for a firm without any machinery.

I also include the year in which the firm was founded (FOUND) as a control for firm quality/reputation. Education of the owner would be the most natural measure of human capital. Unfortunately, education was only collected for entrepreneurial firms; as a result, this variable is missing for about 30% of the sample. [8]

Industry dummies are included where appropriate. The sectors covered by the survey include: Food Processing; Textiles and Clothing; Wood and Furniture; and Metal Products. These were meant to cover the bulk of manufacturing activity in the countries where the interviews took place, while allowing the survey to be sufficiently narrow as to have a reasonably large number of observations per industry.

I do not have any way of explicitly measuring demand-side shocks. These effects, however, are presumably absorbed to a large degree by the industry and country dummies.

The original sample contained 1,223 firms, with between 202 and 275 observations in each country. Firms with missing observations on WORKERS or with WORKERS < 10 were dropped (162 and 386 firms, respectively), [9] as were firms with CU $= 0$ (1) or CU missing (27); firms with missing observations on INVDUM (96), CREDIT (2) or LACCR (4) were also dropped. This yielded a basic sample of 545 firms.

Summary statistics for the above variables are listed in Table 1, disaggregated by country. Probably the most important item to note is that Tanzania has an *extremely* low rate of supplier credit, while the rate is much higher for Zimbabwe than for any other in the sample. This may be important in the interpretation of some of the results which follow.

4. RESULTS

(a) *Supplier credit and capacity utilization*

The basic relationship between supplier credit and capacity utilization is described by the following model:

Table 1. *Summary statistics*[a]

	All firms					
	Full sample	Côte d'Ivoire	Kenya	Tanzania	Zambia	Zimbabwe
CU	61	76	71	45	49	68
CREDIT	0.35	0.30	0.40	0.08	0.19	0.69
INVDUM	0.80	0.75	0.87	0.80	0.59	0.93
INVENT	0.11	0.05	0.12	0.13	0.06	0.13
WORKERS	203.82	178.32	146.54	164.08	131.50	357.42
log(WORKERS)	4.26	4.01	4.08	3.86	4.15	4.90
DEP	0.97	0.91	0.99	0.99	0.97	0.96
OVERD	0.68	0.53	0.91	0.36	0.64	0.82
LOAN	0.18	0.18	0.21	0.01	0.10	0.22
FOUND	1972.57	1972.76	1971.45	1974.72	1971.71	1965.64
Obs.	545	53	121	107	124	140

[a] Variable definitions: CU—rate of capacity utilization; CREDIT—proportion of a firm's three main suppliers that provide goods on credit; INVDUM—dummy variable denoting whether the firm has raw materials on hand; INVENT — (raw materials inventories)/sales; WORKERS—number of employees; DEP—dummy variable denoting whether the firm has a bank account; OVERD—dummy variable denoting whether the firm has access to overdraft facilities; LOAN—dummy variable denoting whether the firm received a bank loan in the past year; FOUND—year in which the firm was founded.

$$\mathrm{CU}_i = \alpha + \beta_1 * \mathrm{CREDIT}_i + (\boldsymbol{\beta}_2 * \boldsymbol{X}_i + \boldsymbol{\eta}_j + \boldsymbol{\nu}_k) + \varepsilon_i, \quad (1)$$

where firm i is in industry j and country k; $\boldsymbol{X}_i$ is a vector of firm-specific characteristic; ε_i is the error term; and $\boldsymbol{\eta}_j$ and $\boldsymbol{\nu}_k$ are industry and country fixed-effects, respectively. The results of this set of regressions are given in Table 2; the coefficient on CREDIT is consistently positive across a number of specifications, taking on values of around 5.5 (significant at 10%). Given that the mean rate of capacity utilization for firms in the sample is 60%, this suggests that for an average firm, access to supplier credit may increase capacity utilization by up to 10%. None of the other measures of credit access were relevant in explaining capacity utilization. This seems surprising at first—if there exists some degree of fungibility of funds, different forms of credit should be close substitutes. In particular, overdraft protection, which is also a form of working capital financing, should have a similar effect to that of supplier credit. But, the conditions attached to these two forms of financing are very different. While many firms have access to overdrafts, managers avoid their extensive use, primarily because of the prohibitively high interest rates that banks demand on overdraft balances. [10] Managers that I spoke with expressed concerns that these extremely high interest rates could lead to a "debt spiral" if funds to pay off the loan did not materialize quickly.

This point is made quite clearly from firms' responses to questions regarding the costs of financing in the third round of the RPED survey. Owners were asked to rank the cost of finance, from one (very low) to six (very high). Supplier credit was rated as having a low cost, with an average of about two for all firms (less than three for every country in the sample), as compared to overdraft financing, which received an average rating of around five (higher than four for every country). Furthermore, the implicit interest rate on supplier credit was often 0% (for more than half of credit transactions) and averaged about 15%. By contrast, the average rate on overdrafts was well above 30%, and rates over 100% were quite common.

The description of the mechanism through which supplier credit improves capacity utilization in Section 1 suggests that the simple model described by Eqn. (1) may not be appropriately specified. More precisely, we expect that supplier credit should matter more for firms that require higher inventories (and therefore greater working capital) due to uncertain demand and supply conditions, longer throughput times, and other such lags. As a proxy for a firm's underlying "inventory needs," I use the average of inventory intensity, taken at the industry-country level (AVINV, see above for definition), effectively assuming that some elements of the firm's inventory needs are due to industry- and country-specific factors. For ease of interpretation, AVINV is scaled to take on values between zero and one using a linear transformation.

To investigate the relationship between the effect of supplier credit and "inventory intensity," I ran an augmented version of (1), with AVINV and AVINV $*$ CREDIT added as regressors; the results are listed in the second column of Table 2. Consistent with the prediction that supplier credit will have a greater impact in firms where inventory requirements are greater, the coefficient on the cross-term AVINV $*$ CREDIT is positive, and statistically significant at 5%.

As previously discussed, there are significant issues of endogeneity of credit access in the above analysis. These concerns are partly tempered by the results involving CREDIT interacted with industry inventory intensity (AVINV). While omitted variable bias could certainly lead to a spurious correlation between CREDIT and capacity utilization, it is not clear that CREDIT should be *more* correlated with unobserved firm quality in inventory-intensive industries. It will still be important, however, to try to instrument for CREDIT; I do so using average length of supplier relationship (LENGTH), and whether supplier markets are competitive (COMPETITION). Numerous previous studies (for example, McMillan & Woodruff, 1999; Fisman, 2000), have found a positive effect of length of relationship on credit provision, which is explained by a gradual buildup of trust. Thus, after controlling for the longevity of the firm, it seems plausible that LENGTH only affects capacity utilization through its effect on credit access, thereby making it a valid instrument. Other work has also shown a strong relationship between upstream market structure and credit provision (see Fisman & Raturi, 2000). Again, after controlling for firm quality and location effects, it is plausible that COMPE-

Table 2. *Effect of supplier credit on capacity utilization full sample*[a,b]

Dependent variable: CU	(1)	(2)	(3)	(4)	(5)	(6)	
CREDIT	5.89**	5.47*	5.47*	5.48*	5.58**	5.66**	5.58**
	(2.79)	(2.80)	(2.81)	(2.81)	(2.82)	(2.84)	(2.81)
log(WORKERS)		0.48	0.47	0.47	0.54	0.65	0.96
		(0.70)	(0.72)	(0.71)	(0.77)	(0.80)	(0.76)
LOAN			0.12	0.12	0.20	0.11	−3.08
			(2.00)	(2.01)	(2.04)	(2.06)	(2.64)
DEP				−0.15	−0.04	−0.02	1.68
				(5.01)	(5.02)	(5.01)	(4.94)
OVERD					−0.74	−0.67	−0.92
					(2.47)	(2.47)	(2.41)
FOUND						0.03	0.06
						(0.06)	(0.06)
AVINV							3.11
							(6.04)
AVINV * CREDIT							26.07**
							(10.53)
Wood	6.47	6.34	6.33	6.32	6.34	6.39	8.54
	(2.40)	(2.44)	(2.44)	(2.45)	(2.45)	(2.46)	(2.82)
Food	5.76	5.57	5.57	5.57	5.62	5.61	5.69
	(2.47)	(2.50)	(2.51)	(2.51)	(2.51)	(2.51)	(2.55)
Textiles	8.03	8.06	8.05	8.05	8.03	8.02	8.86
	(2.79)	(2.78)	(2.79)	(2.82)	(2.82)	(2.83)	(2.83)
Kenya	−6.08	−6.07	−6.12	−6.11	−5.89	−5.76	−9.39
	(3.30)	(3.29)	(3.40)	(3.47)	(3.58)	(3.59)	(5.05)
Tanzania	−30.16	−30.18	−30.19	−30.17	−30.27	−30.18	−33.37
	(3.32)	(3.30)	(3.30)	(3.36)	(3.36)	(3.37)	(5.55)
Zambia	−26.36	−26.44	−26.47	−26.46	−26.41	−26.27	−30.28
	(3.16)	(3.15)	(3.18)	(3.21)	(3.21)	(3.23)	(4.23)
Zimbabwe	−11.65	−11.86	−11.89	−11.88	−11.82	−11.63	−16.22
	(3.46)	(3.48)	(3.51)	(3.56)	(3.58)	(3.60)	(4.99)
CONSTANT	70.34	68.59	68.61	68.75	68.71	12.75	−52.82
	(2.94)	(3.90)	(3.90)	(6.03)	(6.07)	(117.65)	(108.65)
R-squared	0.25	0.25	0.25	0.25	0.25	0.25	0.26
Obs.	545	545	545	545	545	545	545

[a] Variable definitions: CU—rate of capacity utilization; CREDIT—proportion of a firm's three main suppliers that provide goods on credit; INVDUM—dummy variable denoting whether the firm has raw materials on hand; INVENT—(raw materials inventories)/sales; WORKERS—number of employees; DEP—dummy variable denoting whether the firm has a bank account; OVERD—dummy variable denoting whether the firm has access to overdraft facilities; LOAN—dummy variable denoting whether the firm received a bank loan in the past year; FOUND—year in which the firm was founded; AVINV—average rate of inventory intensiveness, at the industry-country level.

[b] Standard errors, corrected for heteroskedasticity, are reported in parentheses; AVINV and CREDIT are expressed as deviations from the sample means.

* Significant at 10%.

** Significant at 5%.

TITION only affects capacity utilization through its impact on credit access.

The first-stage regression is thus:

$$\begin{aligned}\text{CREDIT}_i = &\alpha + \beta_1 * \text{LENGTH}_i \\ &+ \beta_2 * \text{COMPETITION}_i \\ &+ (\boldsymbol{\beta}_2 * \boldsymbol{X}_i + \boldsymbol{\eta}_j + \boldsymbol{\nu}_k) + \varepsilon_i.\end{aligned}$$

In the first stage, the instruments are jointly significant (*F*-statistic is significant at 5%), and the two instruments easily pass the test of overidentifying restrictions (though this is, of course, a very weak test). The results from the regressions with the fitted values of CREDIT are reported in Table 3. The basic patterns remain unchanged when CREDIT is instrumented for. The point estimate on the fitted

Table 3. *Effect of supplier credit on capacity utilization instrumental variable results*[a,b]

Dependent variable: CU		
CREDIT	6.39	−0.19
	(5.45)	(4.59)
AVINV		−0.16
		(1.61)
AVINV * CREDIT		35.61**
		(8.15)
log(WORKERS)	0.57	0.91
	(0.75)	(0.67)
LOAN	−1.66	−1.41
	(1.62)	(1.69)
DEP	0.61	1.48
	(4.58)	(4.62)
OVERD	−0.03	0.30
	(2.64)	(2.64)
FOUND	0.07	0.07
	(0.05)	(0.05)
R-squared	0.25	0.26
Obs.	527	527

[a] Variable definitions: CU—rate of capacity utilization; CREDIT—proportion of a firm's three main suppliers that provide goods on credit, instrumented using average length of supply relationship and supplier market structure; INVDUM—dummy variable denoting whether the firm has raw materials on hand; INVENT—(raw materials inventories)/sales; WORKERS—number of employees; DEP—dummy variable denoting whether the firm has a bank account; OVERD—dummy variable denoting whether the firm has access to overdraft facilities; LOAN—dummy variable denoting whether the firm received a bank loan in the past year; FOUND—year in which the firm was founded; AVINV—average rate of inventory intensiveness, at the industry-country level.

[b] All regressions include industry and country fixed-effects; standard errors, corrected for heteroskedasticity, are reported in parentheses; AVINV and CREDIT are expressed as deviations from the sample means. * Significant at 10%; ** significant at 5%; *** significant at 1%.

value of CREDIT is somewhat larger, while its significance is diminished, and not significant at conventional levels. Similarly, the results involving CREDIT * AVINV in Table 3 closely parallel those in the previous table, with a very high level of significance on this interaction term.

(b) *Trade credit, inventories, and capacity utilization*

We may further break down the data to look at the mechanism through which supplier credit affects capacity utilization. Referring again back to the model in Section 2, credit affects capacity utilization through a two-step process: firms with more credit are less likely to stock out of raw materials; raw materials stockouts, in turn, will affect capacity utilization, particularly in "inventory-intensive" sectors. Note that in areas where inventories are less crucial, raw materials stockouts may not necessarily be a negative sign, and may even be interpreted as a signal of efficient inventory management.

The equations implied by the preceding paragraph are the following:

$$\mathrm{INVDUM}_i = \alpha + \beta_1 * \mathrm{CREDIT}_i + (\boldsymbol{\beta}_2 * \boldsymbol{X}_i + \boldsymbol{\eta}_j + \boldsymbol{\nu}_k) + \varepsilon_i, \quad (2a)$$

$$\mathrm{CU}_i = \alpha + \beta_1 * \mathrm{INVDUM}_i + \beta_2 * \mathrm{INVDUM}_i * \mathrm{AVINV}_i + \beta_3 * \mathrm{AVINV}_i + (\boldsymbol{\beta}_4 * \boldsymbol{X}_i + \boldsymbol{\eta}_j + \boldsymbol{\nu}_k) + \varepsilon_i. \quad (2b)$$

The interpretation of (2a) is relatively straightforward. For (2b), the coefficient of primary interest is β_2, which we expect to be positive—that is, in more "inventory-intensive" industries and/or locations, we expect stockouts to be more costly. The results from these regressions are shown in Table 4. As illustrated by Table 4(a), there is a very strong relationship between access to supplier credit and probability of inventory stockouts.

It is certainly possible that the causality runs in the opposite direction—that is, firms that do not require substantial inventories also do not have any need of supplier credit, and as a result, report that they do not have supplier credit access. When supplier credit its instrumented for, however, its effect on inventory holdings remain strong, though somewhat weakened (point estimate falls to 0.15, and significance is reduced to the 10% level).

The next step, i.e., the regression relating inventory stockouts to capacity utilization, is listed in Table 4. The coefficient on INVDUM is positive, though significant only at 10%, and quite small (about 4.4). Hence, for the average firm, the relationship is relatively weak. But, the coefficient on the interaction term INVDUM * AVINV is positive and significant at 10%, taking on a value of 17. So, for a one standard deviation (0.25) increase in AVINV, there is an associated increase in the coefficient

Table 4. *Relationships between supplier credit, inventory stockouts, and capacity utilization—full sample*[a, b]

(a) Relationship between supplier credit and inventory stockouts Dependent variable: INVDUM		(b) Relationship between inventory stockouts and capacity utilization Dependent variable: CU		
CREDIT	0.203*	INVDUM	4.17**	4.30**
	(0.043)		(2.63)	(2.66)
log(WORKERS)	0.064*	AVINV		−11.19
	(0.013)			(10.48)
LOAN	−0.063	AVINV * INVDUM		17.71**
	(0.043)			(10.01)
DEP	0.211***	log(WORKERS)	0.83	0.92
	(0.108)		(0.78)	(0.79)
OVERD	0.072	LOAN	−3.02	−2.98
	(0.041)		(2.64)	(2.65)
FOUND	0.000	DEP	0.01	1.09
	(0.001)		(5.34)	(5.42)
CONSTANT	0.099	OVERD	−0.44	−0.44
	(1.91)		(2.44)	(2.42)
		FOUND	0.06	0.07
			(0.06)	(0.06)
		CONSTANT	−39.18	−62.08
			(107.46)	(107.98)
R-squared	0.22		0.25	0.25
Obs.	545		545	545

[a] Variable definitions: CU—rate of capacity utilization; CREDIT—proportion of a firm's three main suppliers that provide goods on credit; INVDUM—dummy variable denoting whether the firm has raw materials on hand; INVENT (raw materials inventories)/sales; WORKERS—number of employees; DEP—dummy variable denoting whether the firm has a bank account; OVERD—dummy variable denoting whether the firm has access to overdraft facilities; LOAN—dummy variable denoting whether the firm received a bank loan in the past year; FOUND—year in which the firm was founded; AVINV—average rate of inventory intensiveness, at the industry-country level.

[b] All regressions include industry and country fixed-effects; standard errors, corrected for heteroskedasticity, are reported in parentheses; AVINV and CREDIT are expressed as deviations from the sample means.

* Significant at 1%.

** Significant at 10%.

*** Significant at 5%.

on INVDUM of about four. Hence, for firms facing high inventory requirements, the data suggest that stockouts may be very costly.

The above results may in some sense understate the importance of trade credit: the description of the role of supplier credit outlined in the previous section emphasizes that this type of credit will be particularly important for firms with liquidity constraints. In other words, supplier credit is a substitute (albeit a very important one) for other sources of funds. Thus, for example, the effect from supplier credit should be less among those firms with access to overdraft facilities—while, as explained above, trade credit is strongly preferred to the use of overdrafts, we still expect the two to be weak substitutes. Consistent with this observation, the coefficient on CREDIT is somewhat higher among firms that do not have access to overdraft facilities (8.5 for firms without overdraft facilities, vs. 4.5 that do have overdraft protection).

There are many such sources, both formal and informal, that could potentially provide liquidity for the firm, thereby obviating the need for supplier credit. To try to net out these well-financed firms, regressions from Tables 2 and 4(b) were repeated with the sample divided into two parts: (i) those with $\text{LACCR} = 0$ (firms that claimed that credit constraints were not a limiting factor for the expansion of their business), and (ii) those with $\text{LACCR} > 0$ (firms facing some credit constraints). Supplier credit should be far more important among firms in the latter group. The results of the regressions for firms with $\text{LACCR} > 0$, reported in Table 5, confirm this hypothesis. Consistent with expectations, the coefficient on CREDIT is substantially higher than in the

Table 5. *Relationship between supplier credit, inventory stockouts, and capacity utilization—firms with* LACCR > 0[a,b]

(a) Relationship between supplier credit and capacity utilization Dependent variable: CU		(b) Relationship between inventory stockouts and capacity utilization Dependent variable: CU	
CREDIT	9.31*	INVDUM	9.47**
	(3.91)		(2.82)
AVINV	7.38	AVINV	−10.60
	(7.09)		(11.75)
AVINV * CREDIT	15.30	AVINV * INVDUM	21.58***
	(13.13)		(11.46)
log(WORKERS)	2.01	log(WORKERS)	1.80
	(0.95)		(0.97)
LOAN	−2.42	LOAN	−2.64
	(3.15)		(3.06)
DEP	2.30	DEP	2.43
	(6.16)		(7.10)
OVERD	−0.39	OVERD	−0.23
	(3.06)		(3.00)
FOUND	0.16	FOUND	0.17
	(0.09)		(0.09)
CONSTANT	−239.20	CONSTANT	−265.00
	(171.98)		(168.59)
R-squared	0.32		0.32
Obs.	346		346

[a] Variable definitions: CU—rate of capacity utilization; CREDIT—proportion of a firm's three main suppliers that provide goods on credit; INVDUM—dummy variable denoting whether the firm has raw materials on hand; INVENT—(raw materials inventories)/sales; WORKERS—number of employees; DEP—dummy variable denoting whether the firm has a bank account; OVERD—dummy variable denoting whether the firm has access to overdraft facilities; LOAN—dummy variable denoting whether the firm received a bank loan in the past year; FOUND—year in which the firm was founded; AVINV—average rate of inventory intensiveness, at the industry-country level.

[b] All regressions include industry and country fixed-effects; standard errors, corrected for heteroskedasticity, are reported in parentheses; AVINV and CREDIT are expressed as deviations from the sample means.

* Significant at 5%.

** Significant at 1%.

*** Significant at 10%.

full-sample regressions, and is equal to about 9.5. This is quite a dramatic effect, given that the mean for CU is about 60. When the interaction term is added, its coefficient is also positive, though somewhat smaller in magnitude than in the full-sample regression. [11] By comparison, among firms with LACCR $= 0$, the coefficient on CREDIT is approximately zero (0.88).

The results are even more striking in the regressions relating stockouts to capacity utilization. The average effect from stockouts more than doubles, with the coefficient on INVDUM taking on a value of about 10.5; the coefficient on the interaction term also increases substantially. Both coefficients are significant at 1%. By contrast, the regressions involving firms with LACCR $= 0$ yield coefficients that are insignificantly different from zero, and actually negative in the case of the coefficient on INVDUM.

5. IMPLICATIONS AND CONCLUSIONS

The results reported in this paper suggest that there may be significant productivity gains from an increase in the availability of supplier credit. Now, there are various steps that could potentially be taken to increase trade credit provision, including better credit information for suppliers (i.e., a credit clearinghouse) and improved contract enforcement for credit liabilities. Considerable care must be exercised, however, in reaching any policy conclusions, since there may be very good reasons why certain firms do not have access to credit, and it may not be socially optimal to provide trade credit to firms that currently do not receive any, even if it would improve inventory management and increase capacity utilization, as they may simply be too unreliable or pose too great a credit risk. Further examination of this, and related issues, is left open for future work.

NOTES

1. For example: Africa (Fafchamps, 1997; Biggs & Raturi, 1998); Asia (McMillan & Woodruff, 1999); Latin America (Woodruff, 1998).

2. Surprisingly, they actually find a negative relationship between contractual risk and inventory holdings. There are numerous explanations for this, some of which have been documented in a case study by Gulyani (1998) of the Indian automobile industry. Important sources of delays include poor communications infrastructure, since this may result in miscommunication, and may also require that requests be made via messenger, rather than telephone. Furthermore, if any inputs need to be imported, licensing and inspection delays are often long and unpredictable. The same set of factors will increase the time-to-sale of finished goods.

3. For each country covered by the survey, more detail on the data and its collection may be found in the *RPED Final Report* for that country.

4. One problem with CREDIT is that firms often derive the bulk of their raw materials from a single supplier. I also calculated two binary measures of credit access: one that takes on a value of one if the firm received credit from *any* of its suppliers, and another that is equal to one if and only if the firm's *principal* supplier gave it credit. All three measures of credit are highly correlated, and the results are not substantively affected by the variable chosen.

5. All the analyses below were repeated using INVENT (see below), and yielded qualitatively identical results. But, the results derive entirely from stockouts, i.e., if the sample is limited to firms with positive inventories, the effect disappears.

6. This yielded values ranging from zero to 12.5; firms with INVENT > 0.5 were dropped from the sample for the calculation of averages that follows.

7. Other size measures, such as log(sales), were also used; the results were unchanged by this choice.

8. Its inclusion does not, however, affect any of the results, and the relatively minor differences in results arise due to changes in the sample, rather than the inclusion of education as a control. This difference in results could potentially stem from a selection bias created by discarding all corporations from the sample.

9. Number of observations dropped are listed in brackets; the attrition is done sequentially.

10. Examining why it is that overdrafts are more expensive than trade credit is an issue that continues to be debated in the credit literature, and is beyond the scope of this paper.

11. The uninteracted term is sufficiently large that even for firms in the most inventory intensive circumstances, the coefficient on CREDIT is higher for firms with $LACCR > 0$ than those with $LACCR = 0$.

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