Artículos

INVENTORIES AND LOGISTIC COSTS IN DEVELOPING COUNTRIES: LEVELS AND DETERMINANTS, A RED FLAG ON COMPETITIVENESS AND GROWTH[+]

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Abstract

Countries in Latin America and elsewhere are aggressively opening markets for their products through bilateral treaties and pursuing export-led strategies. Yet to fully capitalize on the benefits of those strategies, countries need much more improved logistics. Logistics are significantly high in Latin America and a significant component of those costs are inventory levels. Then the need to reduce those types of costs. We find that raw materials inventories in the manufacturing sector in the 1970s and 1980s and 1990s were two to five times higher in developing countries than in the United States, despite the fact than in most developing countries real interest rates are at least twice as high. Given the high costs of capital in most developing countries, the impact of those high inventory levels on the cost of doing business, and productivity/competitiveness is enormous. Poor infrastructure and

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ineffective regulation as well as deficiencies in market development rather than the traditional factors used in inventory models such as interest rates and uncertainty are the main determinants and explain these differences. Cross-country estimations show that a one standard deviation worsening of infrastructure increases raw materials inventories by 27% to 47%. Poor functioning markets, as measured by the ratio of transfers and subsidies to GDP, are also an important factor with a one standard deviation change leading to a 19% to 30% increase in raw materials inventories. We show that these increases in raw materials inventories are not offset by a decrease in finished goods inventories upstream. The policy implications are clear and strong, improvements in infrastructure and logistics, better regulation and development and deregulation of markets.

I.- Introduction

Globalization trends worldwide are shrinking distances, enabling countries to connect through markets, trade, information, finance and investment. Technological advances in information, communication and transportation have facilitated these processes. Alongside, numerous regional trade blocks have emerged, as countries seek comparative advantages and ease their entry into world markets (Lakshmanan et al., 2001).

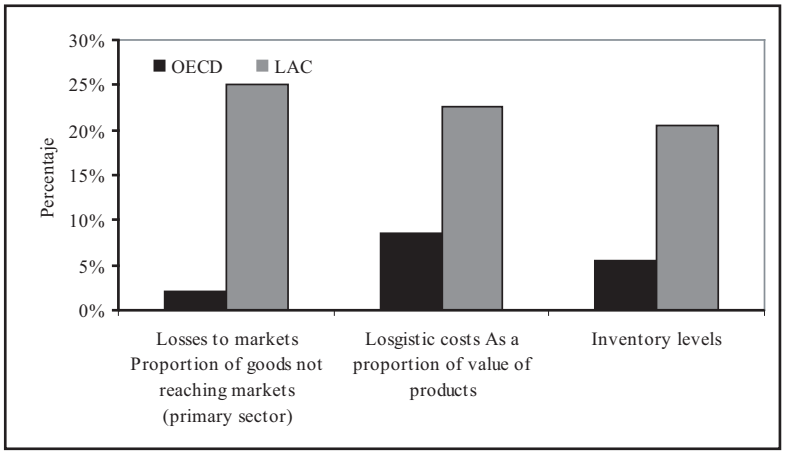
Many leading firms over the world have recognized the strategic importance and priority of logistics within this global competitive environment, and are investing more aggressively in newer logistics systems in an effort to trim costs, improve efficiency, and respond faster to changes in market conditions. As the logistics and supply chain business has evolved over the past ten years, the industry has moved away from thinking of warehousing and transport as separate discrete subjects to viewing the supply chain as a whole.

Logistics costs are large, even aside from trade policy barriers and even between apparently highly integrated economies. Despite many difficulties in measuring and inferring the height of logistic costs and their decomposition into economically useful components, the outlines of a coherent picture emerge from recent developments in data collection and especially in structural modeling of costs. Logistics costs have economically sensible magnitudes and patterns across countries and regions and across goods, suggesting useful hypotheses for deeper understanding..

Developing countries face a unique opportunity to participate competitively in this global and regional production and trading system, offering value-added services, skills resident in their human resources, as well as other resources. However, this opportunity depends on the ability of these countries to meet international market standards that increasingly emphasize high quality and just-in-time delivery.

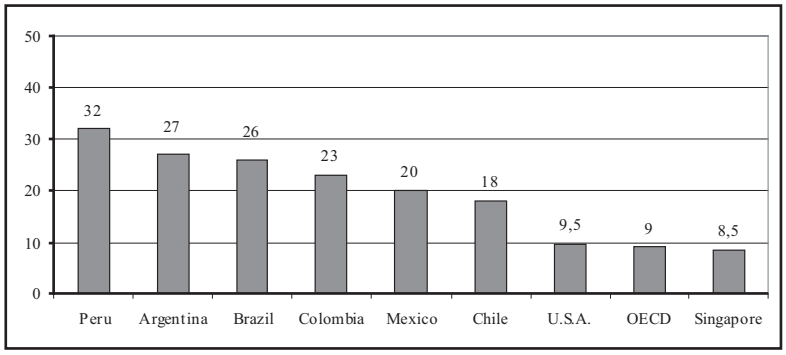
Many Latin American countries are aggressively negotiating bilateral trade agreements to open markets for their products. That is an element of their broader strategy of pursuing export-led growth. Witness the Free Trade agreements with the US of NAFTA and CAFTA-DR, the on- going negotiation of the Andean countries also with the US, bilateral treaties with European Community, with China, Thailand, Singapore etc. While open regimes and the opening of new markets are indeed quite desirable, to fully capture the benefits of those initiatives, a number of complementary reforms need to be undertaken. Countries have to offer desired (by external consumers) products, and have to be offered at competitive prices. A key factor limiting the capture of the benefits of increased integration is logistic costs. As shown in Figures 1 and 2, those costs for most Latin American countries are excessively large. On average they reach 25% when the benchmark of OECD countries is about 9% of product value. Those costs are equivalent to very high external tariffs, yet countries can unilaterally intervene to reduce them drastically. There is substantial evidence that firms from developing countries face higher logistics costs than do firms from developed countries when competing in international markets (Bond, 2001). In particular, excessive logistics costs in LAC have become an obstacle to economic activity and competitiveness in the region. Inventory levels and ports have become a bottleneck in the logistics chain instead of a gateway to the world (Guasch, 2001). While transport costs are a major component of logistic costs so are inventory costs. The motivation of this paper is to assess the levels and determinants of those costs so as to facilitate appropriate government interventions to reduce them and in doing so improve country competitiveness.

FIGURE 1
DETERIORATING AND INSUFFICIENT INFRASTRUCTURE CONTRIBUTES TO UNCOMPETITIVE INDUSTRIES, 2004



Source: various surveys by one of the authors

FIGURE 2
LOGISTIC COST AS A PERCENTAGE OF PRODUCT VALUE, 2004



Source: Various surveys by one of the authors.

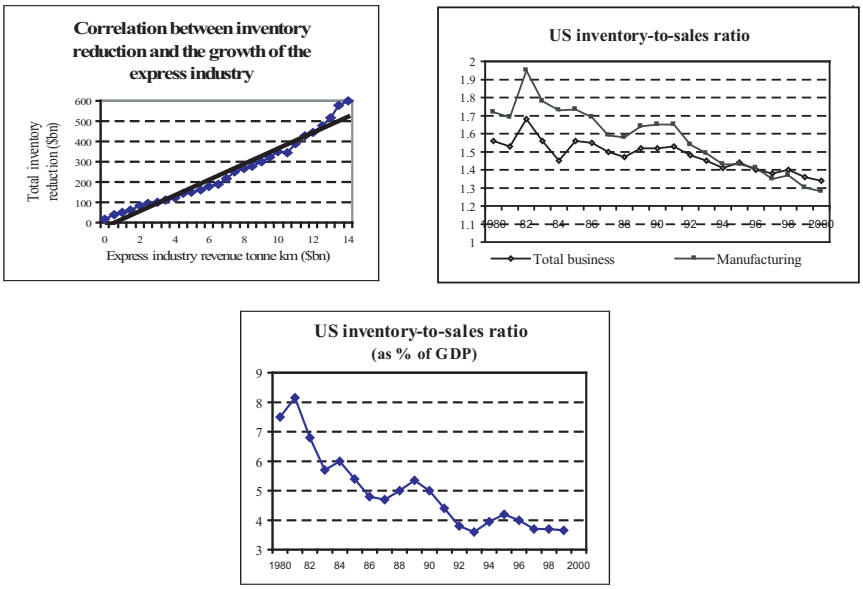
Successful firms understand the need for effective logistics and the need to reduce inventories to secure increased competitiveness, domestically and in foreign markets. Some of the most valuable global trade relies on express cargo aircraft, which are the clipper ships of the modern age, carrying 2 percent of international trade measured by volume but 50 percent measured by value. The logistics industry, however, is about more than just ferrying cargo back and forth. A global hub-and-spoke network is designed to link hundreds of towns and cities with an overnight communications infrastructure that keeps the world's "just-in-time" supply chain taut. In developed markets such as the US, the ability to guarantee overnight shipment of parts and finished goods has allowed companies to reduce average inventory levels by a fifth over the last decade and is thought to have played a significant role in improving productivity across the economy (Figure 3).

The urgency and initiatives seen in many developed countries is only slowly being seen in developing countries. The evidence are the still large inventory holdings in developing countries. While firms bear responsibility and jurisdiction to reduce inventory costs, government's policies also contribute and force firms to optimally have to raise their inventory holdings.

Although it is well known from anecdotal evidence that inventories are higher in developing countries, there are almost no systematic studies that attempt to explain this phenomenon or even to quantify the difference. This study uses newly-assembled data for 52 countries in the early 1970s and 1980s to draw out some stylized facts about the pattern of inventory holdings. Recent data in Latin American countries for the 1990s shows that the problem persist.

The motivation for this paper is the magnitude and the determinants of the inventory holdings and the potential cost to the economy and the impact on competitiveness. And as a result identify government policies that can a significant

FIGURE 3
IMPACT OF THE RISE OF THE EXPRESS TRANSPORT INDUSTRY ON US COMPANIES' COSTS THROUGHT INVENTORY REDUCTION



Source: "Midnight in Memphis, new dawn in China: the world's supply chain battle," by Alexandra Harney and Dan Roberts, Financial Times, September 8, 2004

impact in reducing inventory holdings and so overall logistic costs. U.S. businesses typically hold inventories equal to about 15% of GDP while inventory levels in many developing countries are often twice as large and for raw materials three times as large (Table 1). If the private sector interest rate for financing inventory holdings is 15%-20%, a conservative estimate in most developing countries, then the cost to the economy of the additional inventory holdings is greater than 2% of GDP. They also enter as a component of logistic costs, which, as shown, are excessively high in the Latin America Region.

Suppose that firms in developing countries keep high levels of inventories in response to poor infrastructure and logistic services, which we find in this study to be key determinants. Then, as an example, consider that the total transport infrastructure stock in Bangladesh is about 2% of GDP[1] (World Bank 1994)

[1] Rough calculation based on graphs of infrastructure stock per capita and composition of infrastructure. See World Bank (1994), figures 1 and 2.

while this figure is about 12% in the United States.[2] One year's worth of savings in inventory holding costs would be enough to double Bangladesh's infrastructure stock; the infrastructure improvement could pay for itself. At the firm level, the

TABLE 1
LATIN AMERICA RATIOS TO U.S. INVENTORIES
(all industries)

Raw Materials Inventory Level Ratios: Ratio to U.S. Level by Industry (average of all available data for 1990s)								
	Chile	Venezuela	Peru	Bolivia	Colombia	Ecuador	Mexico	Brazil
Mean	4.17	2.82	4.10	4.20	2.22	5.06	1.90	2.98
Minimum	0.00	0.30	0.20	0.11	0.52	0.86	0.42	0.8
1st Quartile	0.36	1.87	1.20	1.39	1.45	2.55	1.06	1.6
Median	1.28	2.61	2.80	2.90	1.80	3.80	1.36	2.00
3rd Quartile	2.66	3.12	4.50	4.49	2.52	5.64	2.06	3.1
Maximum	68.92	7.21	42.30	34.97	13.59	20.61	3.26	7.1
Final Goods Inventory Levels: Ratio to U.S. Level by Industry (average of all available data for 1990s)								
	Chile	Venezuela	Peru	Bolivia	Colombia	Ecuador	Mexico	Brazil
Mean	1.76	1.63	1.65	2.74	1.38	2.57	1.70	1.98
Minimum	0.01	0.10	0.39	0.11	0.19	0.67	0.35	0.75
1st Quartile	0.17	0.87	1.17	1.13	1.05	1.67	0.82	1.1
Median	0.72	1.60	1.54	2.02	1.28	1.98	1.36	1.60
3rd Quartile	1.38	2.1.4	2.11	3.18	1.63	2.86	2.14	2.00
Maximum	31.61	5.29	3.87	21.31	5.31	7.94	4.91	5.2

Source: Guasch and Kogan (2000)

[2] Nonmilitary nonresidential net public stock in the United States in 1991 was $2.2 trillion with $700 billion of this amount representing stocks of highways and streets. See Munnell (1992), p. 190 for U.S. infrastructure data.

impact of these high levels of inventories is also enormous. Given the high cost of capital in many developing countries, cutting inventory levels in half could reduce unit costs by over 20%, with a significant impact on competitiveness, aggregate demand, and employment.

These calculations are merely a lower bound on the cost of the additional inventory. First, there are certain transactions that would have been worthwhile were it not for the high level of inventory holdings necessary to complete them effectively. It is difficult to estimate the size of these lost transactions. Second, firms in developing countries will take costly steps to mitigate the institutional or structural factors creating a need for high inventories. Suppose that for a particular firm, 30 days of inventory are sufficient when transportation networks are well developed but 90 days of inventory are required when transportation networks are poor. The firm might choose to reduce these 90 days to 60 days by requiring suppliers to locate nearby. Additional costs due to poor infrastructure as measured by increased inventory levels would be 30 days while the actual costs are higher.[3] Third, high inventories can obscure efficiency problems. Current thinking in the manufacturing and operations research field suggests that low inventories make it easier to trace problems in the production process.[4]

The direct impact of inventory costs is quite large as Table 2 shows. Given the high levels of cost of capital, on average they can reach about 19% of product value. While if the countries could rely in near just-in-time strategies those costs could be cut in half, with significant impact on competitiveness and export growth.

The objective of this paper is to systematically report the high levels of inventories in developing countries and to impute their determinants, pointing to policy interventions to considerably reduce those levels. Section 2 of this paper provides a brief theoretical overview of why firms hold inventory and why developing countries might hold more. Section 3 describes the data we have collected. Section 4 contains the estimations which show that inventory levels are significantly higher in developing countries due to poor infrastructure and market interference. Section 5 checks the data for shifting of inventories to upstream industries. Section 6 concludes.

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[3] Gulyani (2000) describes how Maruti, an Indian automaker, tries to decrease inventory costs by encouraging its suppliers to locate nearby through government-sponsored incentive packages and the building of supplier parks. Fisman and Khanna (1998) describes co-location by business group affiliates to overcome infrastructure shortages.

[4] Nahmias (1997), p. 373, states in a discussion of just-in-time inventory management, "A popular analogy is to compare a production process with a river and the level of inventory with the water level in the river. When the water level is high, the water will cover the rocks. Likewise, when inventory levels are high, problems are masked. However, when the water levels (inventory) is low, the rocks (problems) are evident. Because items are moved through the system in small batches, 100 percent inspection is feasible. Seen in this light, just-in-time can be easily incorporated into an overall quality control strategy."

TABLE 2
INVENTORY CARRYING COSTS AS A PERCENTAGE OF PRODUCT VALUE

Element	Average	Ranges
Capital Cost	15.00%	8-40%
Taxes	1.00	0.35-1.52
Insurance	0.05	0.01-0.25
Obsolescence	1.20	0.5-3
Storage	2.00	0-4
Totals	19.25%	9-50%

Source: From various studies

II.- Theoretical Overview

The economics literature typically cites three theoretical reasons for why businesses hold inventory: production smoothing, stockout avoidance, and reduction of transaction costs. Blinder (1991) gives examples of other reasons such as holding inventories for display purposes or to speculate on or hedge against price movements, but the above three explanations are the most prevalent. The mathematical modeling of optimal inventory policies is a field in itself, with much work done by economists, mathematicians, and operations researchers.[5] Here, we merely describe the three reasons intuitively.

In the production smoothing model, firms have a rising marginal cost curve. Firms seeking to minimize production costs in the face of sales that vary predictably over time will produce a constant amount every month, accumulating inventories when sales are below production and depleting inventories when sales exceed production. Firms select their inventory levels by weighing storage and financing costs against potential savings from production optimization.[6]

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[5] Fafchamps et al. (1997) provides some simple mathematical models. For some work by economists on this subject, see Arrow, Karlin, and Scarf (1958), Scarf, Gilford, and Shelly (1963), and Scarf (1960). For articles by mathematicians, see issues of *Siam Journal of Applied Mathematics*. Nahmias (1997) is a commonly used textbook for studying production operations management, covering a number of basic models and providing numerous academic references.

[6] The production smoothing motive does not appear to hold empirically. Blinder (1991) cites three basic facts about U.S. inventories which seem to discredit the production smoothing explanation

(1) Production is more variable than sales in most industries.
(2) Sales and inventory investment normally are not negatively correlated.
(3) The most volatile components of inventory investment are retail inventories and manufacturers' inventories of raw materials and supplies while production smoothing only applies to finished goods inventories.

The stockout motive presumes that demand varies unpredictably over time and any demand that cannot be satisfied immediately out of inventory will be lost rather than carried over into the next period. Firms hold inventory to meet this unanticipated demand. While the production smoothing motive only explains why manufacturers would keep finished goods inventories, the stockout motive explains the existence of retail inventories and raw materials inventories as well. The stockout motive applies also if the uncertainty occurs not in demand but in the timing of deliveries. Firms concerned about stockout optimize inventory levels by trading off holding costs against the likelihood of stockout.

The transaction cost motive assumes that there are certain fixed costs to placing an order or that there are economies of scale in ordering in large batches. When faced with uncertain demand as in the stockout model, firms follow an (S,s) strategy. As soon as the inventory falls below s, the firm places an order of a lot size equal to S-s so that the inventory level for each firm fluctuates between s and S. In determining the optimal lot size, firms weigh inventory holding costs against savings from large orders. According to Mosser (1991), retail inventories are usually managed by an (S,s) rule, as evidenced by its presence in textbooks on purchasing, retailing, and merchandising as well as in trade journals and business reviews which describe implementations of the (S,s) rule using computers.[7]

Poor infrastructure would affect raw materials inventories either through the stockout or transaction cost motive. According to the stockout model, poor infrastructure could increase the time it takes for a shipment to arrive. When a firm finds itself running low on raw materials due to a sudden increase in demand for its finished products, it places an order to replenish its supplies. Since the delivery time is longer, the firm must maintain a larger reserve for this contingency. Alternatively, poor infrastructure makes delivery times more uncertain and firms hold a reserve for the contingency that the delivery takes longer than average. By the transaction cost model, poor infrastructure would increase the fixed cost of each shipment, making small frequent shipments costly. This case might occur, for example, if poor infrastructure resulted in a lack of third party logistics providers who could efficiently handle small shipments. The extent of informatics technology and telecommunications development in any given country can also affect the level and management of inventories by allowing a closer tracking of levels, demand and trends.

Economists have attempted to reconcile these facts with production smoothing by introducing cost shocks but these explanations have not been empirically successful. Fukuda and Teruyama (1988), however, show that the stylized fact that production is more variable than sales is representative of developed economies but not of developing economies.

[7] The transaction cost model predicts that large firms would hold less inventory than small firms when inventory is measured as a fraction of sales. Intuitively, a large firm can place orders in batches to capture economies of scale without spacing its orders far apart. Our analysis of firm level inventory data for several countries in Latin America did not find significant differences between inventory holdings of large and small firms.

The following simple stockout inventory model demonstrates the effect that poor infrastructure would have by increasing transport time. Assume that daily raw materials usage, which fluctuates with current or expected sales, follows a normal distribution with standard deviation σ. If daily deviations from expected usage are independent and additional inventory can be ordered immediately, the safety stock is:

$$S = k\sigma\sqrt{T}$$

k = firm intolerance for running out of inventory
σ = daily standard deviation of inventory levels
T = order time + transit time + handling time

A firm that set k equal to 2 would run out of raw materials inventory less than 2.5% of the time.[8] According to this model, if your supplier is located across the street, you don't need to hold any safety stock as long as the supplier holds finished goods inventories. On the other hand, if the supplier is located two weeks away, an unexpected increase in raw materials consumption during any two week period must be met from raw materials inventory. If daily deviations were instead perfectly correlated—more demand today means more demand tomorrow—then the safety stock would be proportional to T rather than the square root of T.

Inventories should be affected by a number of other factors which are common to developing countries that we will try to control for. First, developing countries which import intermediate goods as manufacturing inputs are likely to have higher inventory levels because the import of raw materials involves longer and more uncertain delivery times as well as greater transaction costs leading to larger and less-frequent shipments. We know from our analysis of data for a few Latin American countries which require firms to account separately for domestic and imported inputs that inventories of imported inputs are much higher. Second, a poorly functioning market can lead to shortages of certain goods; firms expecting these shortages would stock up on inventories in anticipation. In the Soviet Union, firms were known to maintain a high ratio of raw materials inventories to finished goods inventories for this reason.[9] Third, higher uncertainty of demand should lead firms to keep higher inventories according to the stockout model. Finally, the interest rates at which firms can borrow working capital determine the holding cost of the inventories. The higher the interest rates, the costlier are inventory levels; thus one would expect lower levels in equilibrium. Since developing countries have higher interest rates than developed countries, it is then, on that account surprising that their inventories are higher.

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[8] Since any additional orders would incur some fixed ordering costs, the firm may actually prefer a higher safety stock than indicated.

[9] Chikan (1991) shows that socialist countries held a larger ratio of raw materials inventories to finished goods inventories.

There are a number of additional factors that ideally should be included in the study but cannot due to a lack of cross-country data. If developing countries were more likely to use FIFO accounting while developed countries used LIFO accounting, their inventory stocks would appear to be higher, especially in cases of high inflation. Although we do not have evidence by country on this issue, our research on this topic indicates that LIFO, although allowed in the United States for tax purposes, is rare in both developing and other developed countries.[10] Other relevant factors are the degree of vertical integration, the concentration of upstream suppliers, production to stock vs. production to order, and the type of production technology.[11] We do control for some omitted variables by including GDP/capita as our measure of level of development in all of the regressions.

Our approach in this paper is that high inventories are an optimal response to particular characteristics of a developing country. An alternative approach is that high inventories represent firm inefficiency, a result of poor management perhaps. We would not expect this type of inefficiency to be correlated with any of our variables once we control for level of development, and, for this reason, we do not address this type of explanation but rather focus on correlation with country characteristics.

III.- Data Description

It is difficult to obtain consistent time series data on inventory holdings for developing countries. The aggregate data reported in the national accounts is the change in inventories rather than the stock of inventories; often this data is based not on an inventory survey but on the difference between production and sales which leads to highly inaccurate data.[12] Most national statistics agencies do have inventory stock data but they do not publish it. In order to report the size of the country's industrial production, the statistics agency typically carries out a firm survey or census, which asks about total inventory holdings at the beginning or end of the year. More detailed surveys break down inventories into three or more categories: raw materials inventory, goods-in-process inventory, and finished goods inventory. Many surveys also request data on raw materials consumed in production. The United Nations, in its World Programme of Industrial Statistics, surveyed the

[10] See, for example, Nobes and Parker (1995), p.162.

[11] For example, due to the fixed costs of rampup, it is more costly to run out of inventory in a continuous or batch process than in a discrete process.

[12] We note, however, that the initials results of our research using the aggregate inventory levels computed from the National Accounts data were not inconsistent with the stylized observation that developing countries hold more inventory than developed countries.

statistics departments of countries around the world, requesting industrial data for 1973 and 1983.[13] In some cases, this data was provided for an adjacent year but not the year requested. Table 3 (see Appendix 1) describes the data in more detail. 31 countries provided data on inventories for the 1973 survey and 43 countries provided data on inventories for the 1983 survey, yielding a database of inventory data for 52 countries for one or two years. These data were sufficient to calculate the following end-of-year inventory levels:

$$\text{Raw Materials Inventory ratio (EOY)} = \frac{\text{Raw Materials Stock(EOY)}}{\text{Raw Materials Consumed}}$$

$$\text{Final \& Process Inventory ratio (EOY)} = \frac{\text{Total Stock(EOY) - Raw Materials Stock(EOY)}}{\text{Sales}}$$

Beginning-of-year inventories were also reported, permitting the calculation of another set of inventory levels.

Implicit in these calculations is the assumption that inventory levels at a particular point in time are representative of average inventory levels. Since the data are for the entire industry, inventory cycles of individual firms are not important. We do not have to worry that one firm places its orders early in the month as long as another firm orders late in the month. Nevertheless, if inventory cycles are correlated between firms, then the estimate of inventory levels would be inaccurate. For example, if firms consistently run out of inventory after Christmas, then using end-of-year inventory levels would underestimate average inventory levels. Empirically, inventories, at least in developed countries, are cyclical and measuring inventory at any particular point in time may underestimate or overestimate the average inventory level of that country; a country that appears to have high inventory levels may simply be at the top of the cycle. Many developing countries have high rates of inflation leading to additional biases in the inventory level measurements. For example, under a constant annual inflation rate of 10%, real output of $100, an inventory level of 20% and a FIFO accounting system, nominal output would be about $105 and inventory levels, as measured by the above formulas, would be 19% in the beginning of the year and 21% at the end of the year.[14] We compensate for these problems in part by using both beginning-of-year and end-of-year inventories and also using two years for the same country when available.

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[13] Unfortunately, this program was discontinued after 1983.

[14] BOY inventory would be 20 and EOY inventory would be 22. 20/105 is about 19% and 22/105 is about 21%.

IV.- Analysis of Determinants of Raw Materials Inventory

The median raw materials inventory level in our sample over all countries is .21 which means that the median industry holds enough inputs to cover two and a half months of production. For comparison, the median industry in the United States in 1972 had a raw materials inventory level of .11 representing less than one and a half months of use. 10% of our dataset has raw materials levels greater than .5 and 2% has levels greater than 1. Lumpiness and volatility in commodity markets are the most likely explanations of these levels. For most of our analysis we drop any data with raw materials greater than .5 although our results do not depend on the choice of this particular cutoff.[15] For final and process goods inventory, the median for the whole sample is .08 while this figure is .09 for the United States. 99% of this data is less than 0.35. The two sets of inventory levels are only weakly positively correlated with a correlation coefficient of 0.25.

We start our analysis by regressing inventory levels on industry and country dummy variables as follows where i and c index industries and countries covered:

$$\text{Inventory Level}_{I,C} = \sum_i \beta_i \cdot \text{IndustryDummy}_i + \sum_c \gamma_c \cdot \text{Country Dummy}_c + \varepsilon_{I,C}$$

The country coefficients γ are graphed against GDP/capita in Figure 4 (see Appendix 2). We can see that raw materials inventory is negatively correlated with GDP/capita while the relationship with final and process inventory is less clear.

For the remainder of this section, we focus on raw materials inventory. We replace the country coefficients in the regression with country characteristics; essentially, we are trying to explain these coefficients using country characteristics.

$$\text{Inventory Level}_{I,C} = \sum_i \beta_i \cdot \text{IndustryDummy}_i + \sum_x \lambda_x \cdot \text{Country Characteristic}_x + \varepsilon_{I,C}$$

All reported standard errors in the regressions are robust standard errors corrected for clustering at the country level. Resolving which particular characteristic of developing countries leads to high inventory levels is made difficult by the fact that we are starting with a dataset of only 52 countries. The independent variables that we are interested in are not available for all countries and some variables, such as infrastructure and GDP/capita, are highly correlated with each other, making it difficult to differentiate between explanatory variables. Nevertheless, we do obtain

[15] More than half of the data for industry 314 (Tobacco processing) exceeded .5. Omitting industry 314 from the regressions entirely does not affect our results. The remainder of datapoints with raw materials inventory greater than .5 are broadly distributed over all industries. Egypt, Kuwait and Panama had a disproportionate share of these inventories, but excluding these countries also does not significantly affect the results.

significant results in our regressions. Table 4 describes the variables and Table 5 summarizes the values they can take.

TABLE 4
DESCRIPTION OF EXPLANATORY VARIABLES

Telephone mainlines per person	"Telephone mainlines are telephone lines connecting a customer's equipment to the public switched telephone network." Data are the averages of available years over the period 1971-1985.
Infrastructure Quality	Assessment of the "facilities" for and ease of communication between headquarters and the operation, and within the country," as well as the quality of the transportation. Average data for the years 1972 to 1995. Scale from 0 to 10 with higher scores for superior quality. Source: BERI's Operation Risk Index as used in La Porta et al (1999).
Transfers and subsidies/GDP	Total government transfers and subsidies as a percentage of expenditure multiplied by government consumption as a percentage of GDP. "Subsidies and other current transfers include all unrequited, nonrepayable transfers on current account to private and public enterprises, and the cost of covering the cash operating deficits of departmental enterprise sales to the public. Data are shown for central government only. General government consumption includes all current expenditures for purchases of goods and services by all levels of government, excluding most government enterprises. It also includes capital expenditure on national defense and security." Data are the average of available years over the period 1971-1985.
Log GDP per capita	Logarithm of PPP GDP per capita measured in 1985 dollars. Data are the averages over the period 1971-1985. Source: Penn World Tables (Mark 5.6).
GDP Growth	"Annual percentage growth rate of GDP at market prices based on constant local currency." Data are the averages for available years over the period 1971-1985.
Lending Interest Rate	"Lending interest rate is the rate charged by banks on loans to prime customers." Real lending rate is computed using GDP deflator. Data are the average over all available years in the period 1971-1985.
Imports/GDP	"Imports of goods and services represent the value of all goods and other market services provided to the world. Included is the value of merchandise, freight, insurance, travel, and other nonfactor services. Factor and property income (formerly called factor services), such as investment income, interest, and labor income, is excluded." Data are the averages for available years over the period 1971-1985.

Data source for explanatory variables is the 1999 *World Development Indicators* on CD-ROM unless otherwise noted.

TABLE 5
SUMMARY OF EXPLANATORY VARIABLES

Variable	Countries	Mean	Std. Dev	Min	Max
Log GDP/capita	48	8.46	0.75	6.93	9.61
Telephone mainlines per person	52	0.16	0.15	0.00	0.57
Infrastructure Quality	31	6.05	1.84	2.50	9.15
Transfers & Subsidies/GDP	46	0.06	0.04	0.00	0.18
Imports/GDP	49	0.38	0.29	0.09	1.74
Exports/GDP	50	0.37	0.29	0.04	1.65
Lending interest rate (real)	36	0.08	0.15	-0.17	0.81
Growth – Level	49	3.74	2.16	-1.37	8.14
Growth – Standard deviation	48	4.11	2.01	1.54	10.86

Regressions (1), (2), and (3) of Table 6 display the results of regressing raw materials inventory on infrastructure and the presence of a free market, as well as some control variables. We use two proxies for infrastructure, telephone mainlines per person and BERI's infrastructure quality index, which, although more comprehensive, is available for fewer countries. These proxies for infrastructure are significant at the 1% or 5% level; the coefficients suggest that a one-standard deviation worsening in infrastructure increases inventories by 27% to 47% relative to U.S. levels.[16] Our proxy for the lack of a free market is transfers and subsidies to private and public enterprises expressed as a fraction of GDP.[17] A one-standard deviation restriction on the free market increases raw materials inventories by 19% to 30%.

[16] As shown in Figure 4, the U.S. has one of the lowest levels of raw materials inventory. Comparisons with other countries as the denominator would produce a smaller percentage effect.

[17] In another version of this paper, we used stated-owned enterprises and business regulation as two alternate proxies and obtained significant but smaller effects.

TABLE 6
REGRESSIONS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
…Dependent Variable	Raw Materials	Raw Materials	Raw Materials	Upstream Inventories	Upstream Inventories	Upstream Inventories	Raw as % of Raw + Upstream	Raw as % of Raw + Upstream
Log real PPP GDP/capita	-0.0229 (0.0186)	0.0010 (0.0285)	-0.0304* (0.0171)	-0.0328*** (0..0950)	-0.0193* (0.0103)	-0.0320*** (0.0077)	0.0444* (0.0227)	0.0523* (0.0274)
Telephone mainlines per person	-0.2934*** (0.0948)		-0.1968** (0.0928)	0.0950* (0.0539)		-0.0926 (0.0549)	-0.5417*** (0.1695)	
Infrastructure Quality		-0.0300*** (0.0086)			0.0021 (0.0044)			-0.0374*** (0.0076)
Transfers & Subsidies/ GDP	0.7427*** (0.2226)	0.4105** (0.1947)	0.6453** (0.3128)	0.2136* (0.1202)	0.3098** (0.1235)	0.6608*** (0.1238)	0.4385 (0.4809)	-0.3475 (0.4063)
Imports/GDP	0.0290* (0.0166)	0.0372*** (0.0124)	0.0449 (0.0296)				-0.1765 (.1598)	0.1615 (0.1596)
Exports/GDP				-0.0157 (0.0108)	-0.0151 (0.0111)	0.0158 (0.0110)	0.2721 (0.1798)	-0.0767 (0.1856)
Lending Interest rate (real)			-0.0317 (0.0368)			-0.0442*** (0.0149)		
GDP Growth			-0.0113 (0.0073)			-0.0038** (0.0016)		

GDP Growth Standard Deviation			0.0108 (0.0075)			-0.0066*** (0.0019)		
(24 industry dummy variables)	Included	Included	Included	Included	Included	Included	Included	Included
# of clusters (countries)	42	29	31	44	30	32	41	29
R-Squared	.2528	.2897	.2846	.3893	.4291	.4549	.3234	.3518
# of Observations	2086	1627	1408	1962	1642	1271	1554	1307

Robust standard errors corrected for clustering at the country level are in parenthesis.
*Indicated significance at the 10% level; **Indicates significant at the 5% level; ***Indicates significant at the 1% level.
Inventories greater than .5 have been dropped for these regressions.
Coefficients in regressions (1)-(6) represent the effect of an absolute change in the explanatory variable on inventory level expressed as fraction of a year. For exam2ple, if telephone mainlines per person increased from .5 to .6 in regression (1), inventories would fall by .02934 of a year or about 11 days.
Coefficients in regression (7) and (8) represent the effect of an absolute change in the explanatory variable on the percentage of inventories held as raw materials. For example, if telephone mainlines increased from .5 to .6 in regression (7), 5.417% of inventories more are held as raw materials. In the U.S., the median industry holds 57% of inventories as raw materials so that the .1 change in telephone mainlines leads to a 9% change in holdings.

TABLE 7
INPUT-OUTPUT TABLE

	311	**314**	**321**	**322**	**323**	**331**	**332**	**341**	**342**	**351**	**352**	**353**
311	29%	0%	0%	0%	20%	0%	0%	1%	0%	1%	3%	0%
314	0%	34%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
321	0%	0%	43%	48%	9%	0%	20%	1%	0%	0%	0%	0%
322	0%	0%	1%	41%	0%	0%	0%	0%	0%	0%	0%	0%
323	0%	0%	1%	1%	51%	0%	0%	0%	0%	0%	0%	0%
331	0%	0%	0%	0%	0%	66%	22%	12%	0%	0%	0%	0%
332	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%
341	6%	9%	0%	0%	2%	1%	4%	55%	47%	2%	8%	0%
342	0%	3%	0%	0%	0%	0%	0%	0%	36%	0%	2%	0%
351	1%	0%	3%	0%	7%	1%	0%	9%	6%	60%	25%	2%
352	1%	1%	0%	1%	1%	0%	2%	1%	0%	1%	30%	0%
353	1%	1%	1%	0%	1%	1%	1%	1%	1%	4%	3%	14%
355	4%	4%	2%	1%	6%	2%	11%	6%	3%	3%	13%	0%
356	0%	5%	31%	2%	0%	1%	1%	5%	0%	2%	6%	0%
362	2%	0%	1%	0%	0%	1%	1%	0%	0%	0%	1%	0%
369	0%	0%	0%	0%	0%	1%	1%	0%	0%	0%	1%	0%
371	0%	0%	0%	0%	0%	0%	10%	0%	0%	1%	0%	0%
372	0%	0%	0%	0%	0%	0%	3%	0%	0%	0%	0%	0%
381	5%	1%	0%	0%	1%	5%	18%	1%	0%	3%	4%	0%
382	0%	0%	1%	1%	0%	1%	2%	2%	1%	2%	0%	0%
383	0%	1%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%
384	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%
385	0%	0%	0%	0%	0%	0%	0%	0%	2%	0%	0%	0%
390	0%	0%	0%	2%	0%	0%	0%	0%	0%	0%	0%	0%
Sum	49%	58%	86%	98%	99%	83%	99%	96%	98%	80%	96%	18%

(continue...)

TABLE 7
INPUT-OUTPUT TABLE

	355	**356**	**362**	**369**	**371**	**372**	**381**	**382**	**383**	**384**	**385**	**390**
311	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
314	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
321	5%	0%	0%	1%	0%	0%	0%	0%	0%	3%	2%	4%
322	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%
323	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
331	0%	0%	4%	2%	1%	1%	0%	1%	0%	0%	0%	5%
332	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	0%	0%
341	5%	4%	14%	5%	0%	0%	2%	1%	2%	0%	4%	8%
342	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
351	12%	74%	13%	8%	3%	1%	2%	0%	1%	1%	1%	3%
352	0%	1%	1%	1%	0%	0%	2%	0%	0%	1%	0%	2%
353	1%	1%	2%	3%	1%	1%	1%	1%	0%	0%	0%	1%
355	15%	9%	8%	3%	1%	2%	4%	6%	6%	7%	7%	12%
356	47%	6%	0%	2%	0%	3%	1%	0%	1%	0%	2%	8%
362	2%	0%	36%	1%	0%	1%	0%	0%	1%	1%	2%	0%
369	0%	0%	4%	39%	4%	1%	0%	1%	1%	0%	0%	1%
371	1%	0%	0%	3%	51%	2%	41%	24%	4%	5%	3%	6%
372	0%	0%	0%	1%	5%	70%	21%	9%	7%	5%	4%	14%
381	2%	0%	0%	3%	6%	2%	19%	14%	8%	13%	11%	6%
382	4%	1%	5%	2%	9%	5%	5%	34%	3%	7%	2%	4%
383	0%	0%	1%	0%	3%	1%	1%	8%	61%	10%	37%	4%
384	0%	0%	0%	0%	0%	0%	0%	0%	1%	39%	9%	0%
385	0%	0%	0%	0%	0%	0%	0%	0%	1%	3%	11%	0%
390	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	18%
Sum	95%	96%	91%	75%	86%	90%	98%	98%	98%	99%	98%	98%

Each column shows the source of inputs for that industry. This table is used to an accuracy of four decimal places rather than the displayed two digits in the estimations. In four cases, industries were combined to match up ISIC industries with U.S. Census Bureau classifications for Input-Output Tables. Industry 311 includes industry 312 and 313. 323 includes 324. 353 includes 354. 361 includes 369.

The coefficient for imports/GDP is significant but the effect, less than 10%, is rather small.[18] The interest rate coefficient although of the expected sign is not significant.[19] The coefficient for standard deviation of growth rates, our proxy for demand uncertainty, is of the expected sign but also not significant. This proxy is quite poor since it is also a reflection of general economic instability which would deter firms from investing in inventories.[20]

V.- Input-Output Analysis

An important critique of the above analysis is that we are looking at inventory along merely one point of the supply chain. Perhaps inventories are merely shifted from one point in the chain to another. Under just-in-time inventory systems, for example, large firms are able to reduce their own raw materials inventory often at the expense of increasing their suppliers' finished goods inventories.[21] We test for this possibility by considering for each industry the finished goods inventory of upstream suppliers.[22] If there is indeed shifting of inventories, we would expect that if an industry in a developing country has a higher level of raw materials inventories than the average for that industry across countries, then the final goods inventories for upstream suppliers would be lower than the average for that upstream industry across countries.

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[18] In the table, we include imports/GDP in regressions on raw materials inventory and exports/GDP in regressions on upstream inventory since these are the variables we believe should matter theoretically. Our primary results are not affected, however, by including both variables in the regressions.

[19] Since, in many developing countries in the 1970s and 1980s, nominal interest rates were fixed and inflation rates could be one to ten times as large as the fixed interest rates, we expected to find a large range of interest rates resulting in a larger effect on inventory levels. As Table 5 shows there was indeed a large range of interest rates. One explanation for the lack of an effect is that the interest rate we use, the official lending rate to prime customers as reported to international organizations, has little relation to the actual rates at which manufacturing firms can borrow. Alternatively, high interest rates may be due to a lack of trust in the developing country. This lack of trust might cause inventories to be higher, netting out against the effect of high interest rates. We also tried real interest rates but the effect was about the same.

[20] We also tried the inflation rate as a measure of economic instability but this variable was not significant.

[21] See, for example, Fandel and Reese (1991).

[22] An alternative approach would have been to use industry total inventories in estimations rather than separating out raw materials goods and finished goods inventories. We believe that this approach is not appropriate for two reasons. First, we expect the explanatory variables to have different effects on the two kinds of inventories. Second, the relevant total inventories for our estimations is not the sum of raw materials and finished goods inventories within a particular industry but rather the sum of downstream raw materials and upstream finished goods inventories.

We convert a 1996 U.S. Census Bureau input-output table to use ISIC industry classifications. As shown in Table 7, the manufacturing inputs of a firm represent for most industries 90% or more of the total inputs to production. As a result of the aggregation at the 3-digit ISIC level, the largest suppliers for a firm in many industries are other firms in the same industry. In order to compute upstream inventories, we take a weighted average of all the finished goods inventory levels of upstream suppliers, where the weights are given by the percentages in the input-output table.

We find that the increases in raw materials inventories due to poor infrastructure and poor functioning markets is not offset by a decrease in upstream finished goods inventories. Regressions (4), (5), and (6) show that infrastructure does not affect finished goods inventories and that poor markets increase finished goods inventories by 10 to 32%. Real interest rates are significant and of the expected sign here, but the effect is small, about 7% of inventories per standard deviation change. The regressions thus far suggest that poor infrastructure should lead the distribution of inventories to shift downstream. Regressions (7) and (8) examine raw materials inventories as a percentage of total inventories in the chain to confirm this shift.

This check on shifting of inventories is incomplete in several ways. First, we do not have inventory data on non-manufacturing industries and therefore cannot check for the existence of shifting from upstream suppliers such as agriculture, mining, or forestry, or to downstream customers such as the wholesale and retail sectors. Second, we do not have data on the inventories of upstream suppliers and downstream customers abroad, and, for this reason, cannot test for shifting across country borders. Third, the input-output tables do not allow us to distinguish between industries that provide capital equipment and those that provide raw materials. In some cases, the finished goods inventories of upstream suppliers represent capital equipment while the raw materials inventory of the customer do not. Finally, we have used the U.S. input-output table rather than one for a developing country; it is likely, however, that at this level of aggregation, the input-output tables are not that different.

VI.- Conclusion

This paper has introduced a new cross-country dataset on inventories at the industry level into the literature documenting significant levels of inventory in developing countries. Given the high costs of capital in developing countries, usually in the 15% to 30% rate, the impact on unit costs are enormous. We have explored some broad causes of high raw materials inventory levels across countries in the 1970s and 1980s and can confirm the validity of two causes, infrastructure and poor markets, which have been suggested in case studies. Since high inventories are still a problem today in many developing countries, this paper should be useful in understanding one type of obstacle faced by manufacturing firms in these countries

and from a policy standpoint, it indicates the direction to take to address the problem. The policy implications are clear, improvements in infrastructure, roads, ports and telecommunications can have a significant impact in reducing inventory levels, particularly when accompanied with appropriate and effective regulation. Likewise the development and deregulation of associated markets can also have a significant impact on inventory levels and then reducing the costs of doing business.

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APPENDIX 1

TABLE 3
DATA AVAILABILITY

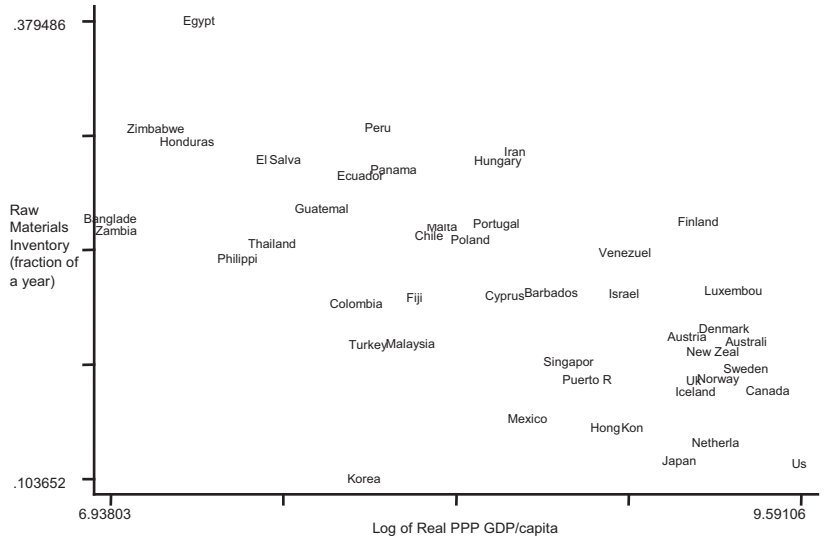
Country	1973 Survey	1983 Survey
Australia	1973	*1984
Austria	1973	1983
Bangladesh		1982
Barbados		1983
Brazil	*1973	
Canada	1973	
Chile	*1973	1983
Colombia	1973	1983
Costa Rica		*1980
Cyprus	1972	1981
Czechoslovakia	1973	1983
Denmark	1973	1983
Ecuador		1983
Egypt		1979
El Salvador		1983
Fiji		1983
Finland		1983
France		*1983
Guatemala	1974	*1983
Honduras	1975	
Hong Kong	1973	1983
Hungary	1973	1983
Iceland		1983
Iran		1983
Israel	1972	1982
Japan	1973	

Country	1973 Survey	1983 Survey
Korea	1973	1983
Kuwait	1974	1983
Luxembourg	1973	
Macau		1983
Malaysia		1983
Malta		1983
Mexico		1983
Netherlands	1974	
New Zealand		1983
Norway	1973	1983
Panama	1973	1981
Peru	1973	*1982
Philippines	1972	1983
Poland		1983
Portugal	1971	
Puerto Rico	1972	
Qatar		1983
Singapore	1973	1983
Sweden	1973	1983
Thailand		1982
Turkey	1970	1983
UK	1973	*1983
US	1972	*1982
Venezuela		1984
Zambia	1973	
Zimbabwe		1983

* Indicates that only total inventory data was available, rather than both total inventory and raw materials invent

APPENDIX 2

Figure 4:Raw Materials Inventory vs. GDP/Capita



Final and Process Inventory vs. GDP/Capita