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Prepare your company for inflation

How companies can learn to live with inflation and its consequences when governments are unable to halt it

Foreword

For decades, companies operating abroad have struggled with the problem of protecting profits against steep rates of inflation. This article briefly reviews a number of strategies that are useful under these conditions, and explores one particular line of strategy in detail—how a company can adjust its product mix to suppress the effects of expanding costs and diminished revenues. The author describes a model by which management can handle the great number of variables that it must consider in making adjustments of this kind. At the heart of this model is a useful definition of the corporation's "personal" rate of inflation. To take full advantage of the approach described, top management may have to expand company surveillance of costs, markets, and inflation differentials.

Mr. Lietaer is a management consultant with Cresap, McCormick and Paget Inc. He has done considerable work on formal approaches to difficult problems that chronically confront companies operating in the international sector. His article, "Managing Risks in Foreign Exchange," appeared in HBR earlier this year, in the March-April issue. He is also the author of *Financial Management of Foreign Exchange*, to be released by The M.I.T. Press in November 1970.

In the United States, the advent of a 6% inflation rate has become a national issue of major importance. But, throughout the world, inflation is today the rule rather than the exception, and our 6% rate of inflation looks insignificant when we compare it with the "galloping" or hyperinflation experienced in some countries.

An Indonesian government communique, for example, welcomed the achievement of a national inflation of only 85% in 1968, which represented a substantial improvement over the 650% rate of 1966. Depreciation of currency values of 20% to 50% a year has not been exceptional in Brazil, Chile, Argentina, Republic of the Congo, or Viet Nam. Nor can hyperinflation be considered a temporary problem. In Argentina, it has been a fact of life, having persisted for a period of 23 years.

More important, worldwide inflation is here to stay for several years at least. The European Economic Community Commission warns that the pressure on prices will be stronger in the next few years. In Japan, the only cloud on the economic horizon is substantial increases in wages, which are expected to push up the price indexes. Some commentators think the United States itself may be caught in an uncontrolled inflation spiral; T. Rowe Price predicts, for example, that "runaway inflation will probably come to the United States in one to three years."[1] Governments certainly experience the

1. *The New York Times*, June 11, 1970.

greatest difficulty in slowing inflation, let alone halting or reversing it.

The pressure that inflation exerts on company profits is obvious. If a fixed revenue declines in value while costs escalate, profits are squeezed out. The company operating in an environment of sharply rising costs can defend itself from this squeeze in a number of ways, and this article aims at expanding a concept of defense strategy developed in bits and pieces by several international corporations that have learned to operate in areas where runaway inflation has posed a critical threat to business.

The inflated conditions in the United States could make this strategic concept increasingly important for companies operating domestically as well as internationally.

Focus on one function

Three corporate functions are dramatically influenced by inflation: cash management, inventory policy, and what might be called "product management," by which I mean the whole body of decisions that relate directly to the products the corporation makes—decisions on the product mix, the markets, and the production and pricing processes. In this article, I shall concentrate entirely on this third function.

I have developed a computerized model to analyze systematically and control the impact of inflation on a corporation, thus allowing management to manipulate the many variables that it must consider in making these product-management decisions. The model integrates the experience of three corporations in Brazil during the 1960's, a period in which price increases in that country were running at over 30% annually. These three corporations—C.P.C. International (formerly Corn Products Co.), Merck & Co., Inc., and Philips Gloeilampenfabriek N.V. (usually known in the United States as Philips Lamp Works)—were all highly successful in protecting their profits against the corrosive effects, not only of inflation, but of price controls as well.

Specifically, the key elements which I have incorporated in the model are: (a) the pricing policies of Corn Products Co.; (b) the product-mix decision techniques of Merck & Co., Inc.; and (c) the information system and manufacturing decision techniques of Philips. Each of these key elements has been empirically tested and actually implemented. Put together in systematic fashion, they represent a broad, new approach to controlling the impact of inflation on a company.

Thus the model describes the combination of changes in product mix, production processes, market strategy, and pricing that best protects a corporation's cash flow and profit margins, and also suggests when each change should be made. Further, this combination can be varied to suit the individual corporation's risk preferences.

The concepts underlying the model are valid in all types of industries. However, as a practical decision tool, the model is best applied in batch-process industries, where the same basic equipment and labor skills can turn out a wide variety of end products. The model might be applied very easily in a chemical laboratory, for example, where the same equipment and personnel can use highly varied raw inputs to produce a virtually unlimited range of end products (and services).

At the other end of the spectrum, the formal applicability of the model would be severely limited for, say, a plate glass manufacturer, whose equipment can only produce a single end product from a relatively fixed group of raw materials. If such a manufacturer decided to switch to making other products, this would amount to his changing industries.

In between these two extremes we have, for instance, pharmaceutical, electronic assembly, shoe manufacturing, textile, furniture, plastics products, and fertilizer companies, in which the model can be more or less straightforwardly applied.

In this article I shall first sketch out the way in which inflation affects a corporation most immediately, and show that the nature of this effect does offer the corporation a foothold for attacking the problem of squeezed profits. The limitations in the model's applicability will then become clear, and I shall get down to specifics on how a company for which the model is suitable can make practical use of it.

Whose inflation?

The current issue of almost any business periodical mentions the rising cost of living in the United States at least once—"the current inflation rate of 5.0% to 6.5% annually." But the question we ought to be asking ourselves is this one: "Whose inflation rate are we really talking about?"

Economists have developed a number of measures of inflation, the most common being the Consumer Price Index, the Wholesale Price Index, and the GNP deflator. Each is better suited than the others for specific econometric purposes, but they all have one aspect in common: they are all irrelevant for most managerial decisions.

We tend to forget that the Consumer Price Index we study so closely is merely the weighted average of the cost of about 400 goods and services most often purchased by the "average" American. It is often an irrelevant measurement of the inflation a specific person or corporation is experiencing. For example, a New York commuter who likes fish and eats out in restaurants has a higher "personal" inflation rate than the worker in Minneapolis who walks to work and dines at home on eggs and chicken.

Everyone in the United States has his own inflation rate, which depends on his consumer habits and preferences. So does every industrial group and every corporation. While the poultry business has actually experienced deflation over the last 10 years, for example, construction companies and hospitals have been living with inflation rates several times higher than the national average.

Measuring a corporation's rate

Two different components determine a corporation's personal inflation rate—the change in the price index of its inputs and the change in the price index of its outputs, or products. The price index for inputs measures the weighted average rate at which the inputs of the corporation are rising. These typically include labor, raw materials, imported products, and so on. In short, this index evaluates the impact of inflation on the corporation's costs.

Similarly, the output inflation index measures the increase in receipts on sales, which is due to selling-price rises in local and foreign markets. In short, this index keeps track of the inflation of the corporation's revenues.

These two indexes are the critical variables a corporation's management should look at when studying the impact of rising prices on its strategies. Since profits are simply the difference between sales revenues and costs, the corporation experiences a powerful profit squeeze when inflation is heavier on costs than on revenues. When both indexes are equal, the corporation's cash flow and profit margins are perfectly protected from inflation. If prices inflate faster than costs, the output index might well exceed the input one, and profits would then rise.

To control the impact of inflation, therefore, a corporation must keep these two indexes in proper balance. In essence, this is what the model helps management to do.

Exhibit I illustrates, in simplified form, how these two indexes might be computed for two separate products, A and B, manufactured by a U.S. corporation in France. Both indexes are computed over the same period, and for the same volume of products made and sold. The exhibited figures incorporate the following assumptions, which are appropriate for a one-year period:

○ The cost of local labor will increase by 10%.

○ The costs of raw materials used to make Products A and B will increase by 40% and 33%, respectively.

○ Import and export prices will remain stable because, among other factors, no devaluation of the French franc is expected.

○ The sales price of Product A in the local market can be increased by 20%.

○ The French government will be successful in freezing the price of Product B at present levels for the next year.

Exhibit I shows that the input inflation index will equal 126.61, and the output inflation index will equal only 103.24. Obviously, profits on A and B may be in danger.

Replacement, not historic, costs

Some critics say computations like these can be misleading because the input index represents an earlier time-frame than does the output index—that comparing them is bad procedure because it ignores the time lag between purchase of inputs and sale of products.

It is quite true that, in actual practice, goods are sold from inventory—there *is* a time lag taken up by production and inventory cycles. In calculations of this kind, however, we should (and do) disregard the production and inventory time, and compute the indexes as if input costs and receipts on sales were simultaneous. We do this because what is important in making managerial decisions is not the *historic* cost—the money spent to produce the item—but the *replacement* cost—the sum that would be required to reproduce the item at the moment of sale.

We use replacement costs rather than historic

Exhibit I. Computation of a company's inflation indexes in France

	Thousands of units (a_i)	Sept. 1970 price in francs (b_i)	Sept. 1971 price in francs	Sept. 1971 index (c_i)	Input inflation index (weighted averages of product input)	
Product A (100,000 produced)						
Local labor (man-hours)	5	200	220	110	123.33*	126.61†
Local raw materials (lbs)	10	500	700	140		
Imported raw materials (lbs)	10	300	300	100		
Product B (250,000 produced)						
Local labor (man-hours)	20	200	220	110	128.16	
Local raw materials (lbs)	25	600	800	133		
	Thousands of sales units	**Present price in francs**	**Future price in francs**	**Future index**	**Output inflation index (weighted averages of product output)**	
Product A						
Local market	50	120	144	120	110	103.24
Export market	50	120	120	100		
Product B						
Local market	100	100	100	100	100	
Export market	100	100	100	100		

*Computed as $\sum_{i=1}^{3} a_i b_i c_i \left[\sum_{i=1}^{3} a_i b_i\right]^{-1}$

†Computed as $\sum_{i=1}^{5} a_i b_i c_i \left[\sum_{i=1}^{5} a_i b_i\right]^{-1}$

costs because of a characteristic of profits under inflation. For example, a widget which cost $10 to manufacture in January could require an outlay of $13 to be reproduced in September. If the cash received on sales in September is $14, actual profit is only $1, the $3 balance being an artificial inventory inflation profit *which should be screened out for product-management decision purposes.* What interests the manager is what it will cost to manufacture the widget today, not four months ago.

Computed in this way, consequently, the input and output indexes measure effectively what will happen to profits as prices spiral. The indexes shown in *Exhibit I*, for example, show that this corporation is bound to have slim profits in France. What can a company management do about a state of affairs of this kind?

Controlling the impact

Conceptually, the solution is very simple: *management must guarantee that the sales receipts on products are higher than the replacement costs.* It can achieve this by one or a combination of four strategies:

1. *Management can increase prices.* This is the easiest and most obvious way to protect profits from inflation. When inflation is moderate, and there are no price controls, it is also the action most frequently chosen. It is used altogether too often, perhaps, for this method of self-protection contributes most to the total inflation of the economy.

In the United States, almost every rise in the prices of inputs over the last year–higher wages for labor, increase in raw materials cost, and so on–has been followed by a similar increase in the price of goods and services to the consumer. Even President Nixon, when faced with new postal labor costs in April of this year, passed the bill on to the consumer by increasing postal stamp prices.

2. *Management can rearrange both suppliers and markets, locally and abroad.* For example, if a corporation is operating in Brazil in a period of steeply rising inflation, it could start purchasing more abroad, in areas of lower inflation, and selling more in Brazil. If a devaluation then occurred in Brazil, it might shift its suppliers and markets again, but in the opposite direction. Of course, the company might find itself constricted by import and export regulations, and would have to perform its shifts within these limitations.

3. *Management can adapt production processes to minimize the inflation of its inputs.* In many instances the same end product can be produced by using different processes with varying types or amounts of raw materials or labor. Thus, development of copper-aluminum electric wiring came about as a reaction to the rising price of copper. One classic reaction has been to automate when labor costs increase faster than those of other inputs.

4. *Management can modify the product mix of the corporation.* If the profit on a particular product is being squeezed out of existence by rising costs and harsher controls, management can slow production of this item and divert the productive capacity thus set free to a more profitable area. If price controls were in effect on bread but not on wheat, for example, and wheat prices were skyrocketing, only a philanthropist would bake bread. A businessman would find something better to do.

Adjusting the product mix has been an escape hatch for many corporations confronted with hyperinflation and drastic price controls. Specifically, it has been a key ingredient of the strategy of Merck, Sharp and Dohme Industria Quimica e Farmaceutica S.A., an affiliate of Merck in Brazil.

This strategy attacks a company's personal inflation rate at its source. Consider what a company has done when it has decided on its product mix. When it has decided what it will make, in what quantities, and by what processes, it has determined its input inflation rate. When it has decided where it will market these products, at what prices, and in what quantities —so much locally and so much in each of various nonlocal markets—it has determined its output inflation rate. In sum, it has fixed its corporate inflation rate.

It is in making these decisions, then, that management can take its initial shots at controlling inflation's effects on company profits.

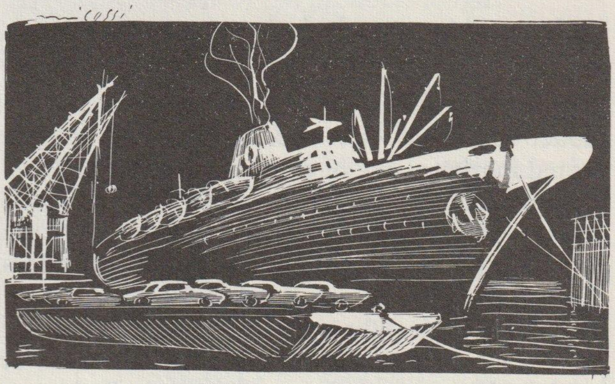
Difficulties & drawbacks

In galloping inflation, a corporation may have to use all four of these techniques simultaneously to keep out of the red, and the procedure of resisting inflation can become very complex indeed. Even the apparently simple technique of raising sales prices frequently involves a high order of management skill. The fourth and more drastic technique of changing the company's product mix, although at times the only way of dealing effectively with galloping inflation, creates really massive complexities.

Let's return for a moment to the U.S. company manufacturing in France. From the viewpoint of defending itself against inflation, clearly this company should drop Product B entirely, for its input inflation will rise to 128.16 over the next year while the government will freeze the sales price at its present level.

However, the decision to drop this product from production obviously cannot be made entirely on the basis of an input index; this product keeps 80% of the labor force occupied, the company has invested heavily in facilities and machinery, it could lose its position in local and export markets indefinitely, and so on. Or if the company were to shift the production capacity devoted to Product B to making more of Product A, but the markets would not absorb the additional quantities of A except at a weakened price, this might make A wholly unprofitable. The company could begin production on another product—but which one, made by what process, offered for sale where?

Uncertainty about inflation rates, costs, and market demand also makes its decisions more difficult. Not all inflation rates can be fore-



casted with the same degree of certainty. Similarly, its information on markets may not be of equal quality. Changing the product mix could drastically modify not only the volume of its earnings but also their variability, and the company should take this factor into account.

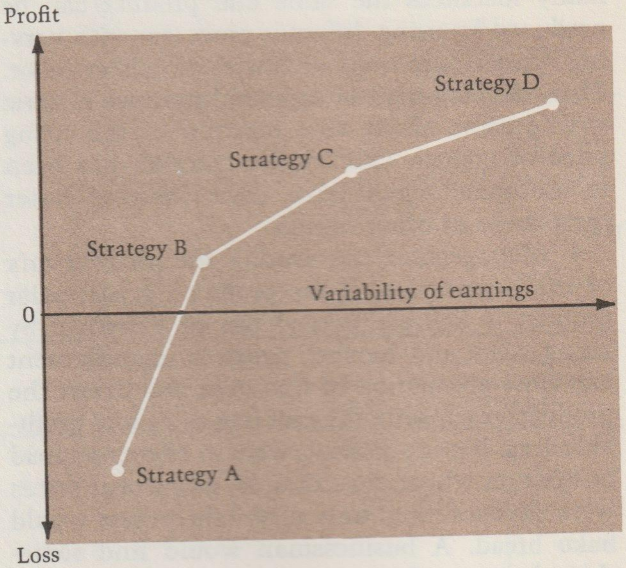
Finally, a large number of complex regulations and constraints limit its freedom to change its product mix at will. Export and import regulations may restrict the kind and volume of raw materials the company imports, and there could be regulations on balances of total hard-currency imports and exports. The company doubtless imposes some restraints on itself for policy or social reasons. For example, it may not want to fire any laborers, or laborers in a particular category.

In addition to these "exterior" considerations, there is the fundamental question of "What industry are we in?" to be taken into account. A company must consider the practical, mechanical limitations on its modifications of product mix. Steel mills do not make watches.

In general, regrouping a company's product mix to compensate for inflationary effects is complicated by three factors: the interlocking web of decisions, made over time, that make up a company's general policy and product-management strategy; the uncertainty of the information and forecasts on which it must base the regrouping; and the government regulations, company goals, and other restraints that constrict management in fashioning the new grouping. If the company has to consider, not just two products, but several hundred, the whole undertaking of modifying product mix to compensate for inflationary effects can become a real headache.

The chief purpose of the model I have developed is to bring these factors under management's control.

Exhibit II. The efficient frontier of corporate strategies



What the model does

Within the limits of all the constraints, the model adjusts product mix to maximize the expected market value of company production and to minimize the expected variable replacement costs of this production. Thus it maximizes the expected profit margin. Likewise, it minimizes the variability or unpredictability of total earnings. This variability could be the result of the uncertainty of forecasted inflation, costs, or market response. It thus gives a steadied view of profit margins. However, the more risk a company is willing to accept, the less important this factor becomes.

The "expected market value of production" is easily defined—this is just the dollar receipts generated by the sales of the products in the export as well as the local markets. The definition of variable replacement costs is a little less obvious.

In the long run, all costs are variable, and therefore the definition of variable costs depends on the time period the model considers. This period is the span between the time management decides on a product strategy and the time revenues are received. This period therefore comprehends the ordering of raw materials, the production cycle, the inventory period, the sales, and finally the credit terms of sales. Depending on the particular industry, the period of the model could range from a few weeks to several years. In addition, any costs which are changing according to the quantity of products turned out during this time period must be considered variable costs.

In short, what the model considers as costs of a product are *all* the variable expenses required to reproduce the product in that future period when cash will be received. The model will select the product mix which will minimize the total variable replacement cost.

The minimization of earnings variability is more complicated still.

'Efficient frontier'

A strategy is optimal when it corresponds to the highest expected profit margins of a given level of variability in earnings. Therefore, in actuality, there is no single corporate strategy which is optimal, but an infinite set of them. At one extreme is the product-mix strategy which gives the lowest possible uncertainty about earnings: it typically corresponds to a product mix for which production costs are very predictable and stable, and for which the market is reliable and well known. As might be expected, the profit margins will usually not be remarkably high.

At the other extreme is the product-mix strategy with the highest possible profit expectations, but for which there is much less certainty of earnings. In between, there are strategies that trade off expected profit margins against the reliability of earnings flows. Among all these strategy options, a management can select the one that best suits its own preconception about the proportionate value of safety and profit opportunity.

Mathematically, one can represent all the optimal solutions as a line on a graph—an "efficient frontier," so called—as shown in *Exhibit II*. The product mix which involves the lowest risk, or the lowest variability in earnings (Strategy A) actually has a negative expected profit margin—an outright loss, in fact. A slightly more aggressive strategy (B) has a higher profit potential, but it also has higher variability. The most aggressive product mix (D) has a sizable expected-profit margin, but at the cost of a substantial uncertainty in the cash flow.

Information requirements

The information required for the model includes hard data on all the variables I have discussed so far. To use the model:

1. Management has to determine the total planning horizon and divide it into time periods. The planning horizon will be at least as long as the longest product cycle—that is, the time which elapses between the ordering of the raw materials for the product and the receipt of cash from its sales. Time periods are merely convenient fractions of this total planning horizon. For example, if the longest product cycle is one-and-a-half years, management could select a total planning horizon of two years with four six-month time periods.

2. Management must list all the possible products the company is willing to make. Then, for each product, it must list a set of practical alternative production processes, along with the product's particular input requirements and mechanical constraints.

For example, a light equipment manufacturer's list of potential products might include industrial ventilators made from different materials and pumps of different types, as shown in *Exhibit III*. A product list ordinarily involves many more items and more complex combinations of raw materials.

3. Management must determine the general inflation for the planning horizon and then, for each input cost, forecast the likely increase due to inflation.

To determine the general inflation, management must obtain forecasts of a basic, common inflation index of the whole economy, for each of the time periods of the model. This could be the Consumer Price Index, the GNP deflator, or any other price index which is a suitable and easy reference point. These forecasts must provide three inflation-rate values for each time unit: (a) the minimum inflation rate possible, (b) the inflation rate most likely to obtain, and (c) the maximum inflation rate possible. For example, management could forecast a basic inflation of between 5% and 10% for the third period, with its most likely value at 7%.

Determining the inflation of individual input costs is not as easy. Management must develop estimates of the *basic* price of each input at the beginning of each period—that is, of the price of this input *before* inflation—along with the sensitivity of this price to the overall inflation.

Suppose, for example, that the cost of a specific class of labor is likely to be $1.00/hour at the beginning of the third period, with a projected maximum of $1.10/hour and a projected minimum of $0.90/hour. Furthermore, suppose management expects the cost of labor to go up exactly as fast as the overall inflation during this period.

Exhibit III. A few of the products a light equipment manufacturer might make

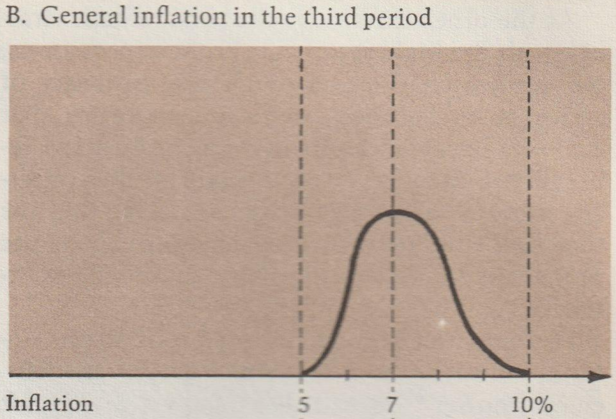
		Raw materials		
Product	Process	Material	Pounds/ 100 units produced	Labor man-days/ 100 units produced
Ventilator, Type Z	Plastic molding	Plastic	350	2
	Injected aluminum	Aluminum	600	3
	Welded plate	Steel plate	500	35
	Stamping	Steel plate	400	5
Pump, Type X	Castings	Iron	800	20
Pump, Type Y	Castings	Iron	600	30

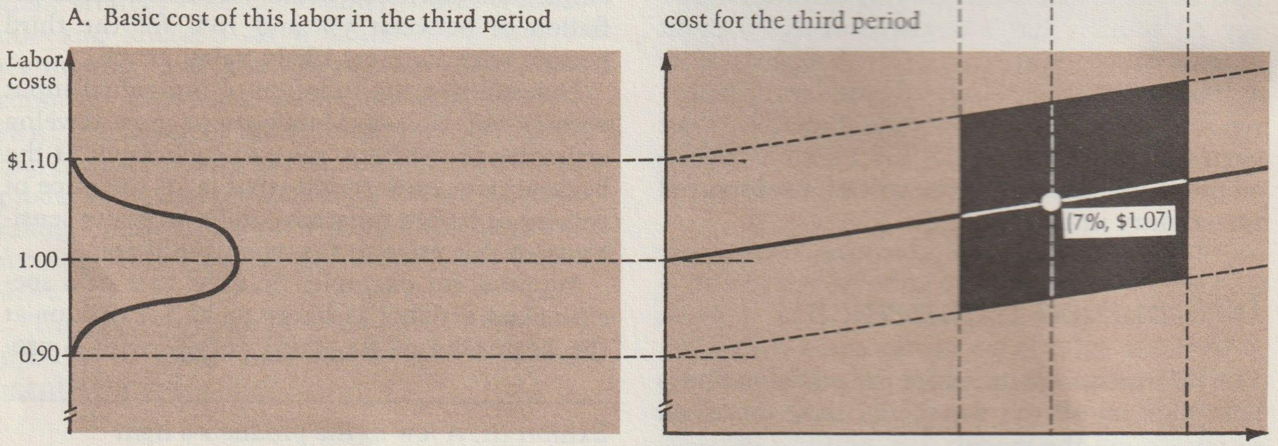
Exhibit IV presents the data to be entered on labor costs in the third period. The *expected* cost of labor at the *end* of the period is $1.07 ($1.00 expected basic cost, plus 7% inflation). However, the combined effect of the uncertainties of the cost at the beginning of the period and of the inflation rate during the period could result in an actual cost anywhere within the black area of Part C of the exhibit.

For all inputs–labor, local raw materials, and imported goods–graphs like *Exhibit IV* should be prepared for each time period.

4. Management must prepare market demand curves for each product during each period that describe the relationship between prices and

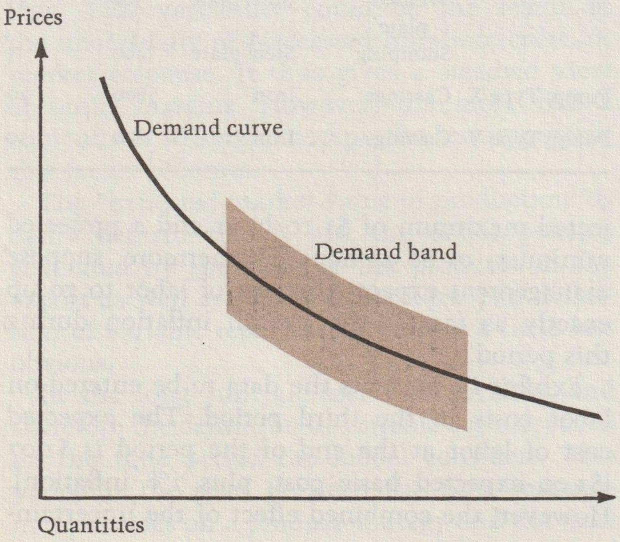
Exhibit IV. Impact of inflation on a specific labor cost during the third period





quantities sold of a product. Actually, the information needed here does not have to be as precise as that usually required for demand curves. A "demand band" would be perhaps a more accurate description, because the model

Exhibit V. Demand band



requires only a reasonable range of quantities and prices for this product. Uncertainty about this range can also be taken into account. While economists would use the precise demand curve shown in *Exhibit V*, the model requires only the demand band shown as the colored area.

5. Management must list all the constraints under which the product mix has to be modified–mechanical constraints, company policies, government regulations, and so on.

All these data are fed into the computer, which produces the full range of optimal corporate strategies, printing out the expected profits and variability of earnings associated with each one.

Example of two strategies

The entire process is best explained by a real, but extremely simplified, example of the selection of a product mix for a U.S. chemical company in Brazil. The potential products are listed in *Exhibit VI*; they include different types of anticorrosion pigments, plastics stabilizers, and

Exhibit VI. Seven products a U.S. chemical company is considering for manufacture

Product	Ingredients/batch (1,000 lbs) Material	Quantity	Labor man-hours/batch
Industrial flame modifier	Lead	450	20.00
	Acids	550	
Plastics stabilizer A	Plastics	650	16.00
	Liquid acids	250	
	Fillings	100	
Plastics stabilizer B	Lead	800	12.80
	Acids	150	
	Wax	50	
Plastics stabilizer C	Lead	800	6.72
	Acids	150	
	Fillings	50	
Anticorrosion pigment A	Oxides	450	12.00
	Silicates	500	
	Fillings	80	
Anticorrosion pigment B	Lead derivatives	600	14.00
	Silicates	300	
	Fillings	120	
Anticorrosion pigment C	Lead derivatives	500	22.00
	Silicates	350	
	Fillings	150	

an industrial flame modifier. The raw materials are similar for some products, but are required in varying proportions. Labor is expressed in man-hours per batch of 1,000 pounds, and includes processing and packaging time. The total planning horizon is fixed at one year, with two six-month time periods.

This example uses the most widely accepted inflation index in Brazil, the Vargas index, as the basic inflation index for the entire economy. The company management expects the following price rises, as measured by this index:

Period	Price rise: Maximum	Expected	Minimum
1	8%	5%	2%
2	15%	10%	8%

For each major input, an inflation graph like that of *Exhibit VII* is prepared, showing the evolution of the price of an hour of labor under the pressure of inflation. Looking at the vertical axis of Part A, we see that the basic cost of labor at the beginning of the first period is 5.0 cruzeiros, with a variation of 10% between 4.5 and 5.5. The expected inflation of the overall economy is represented on the horizontal axis as a probability distribution that gives the possible vari-

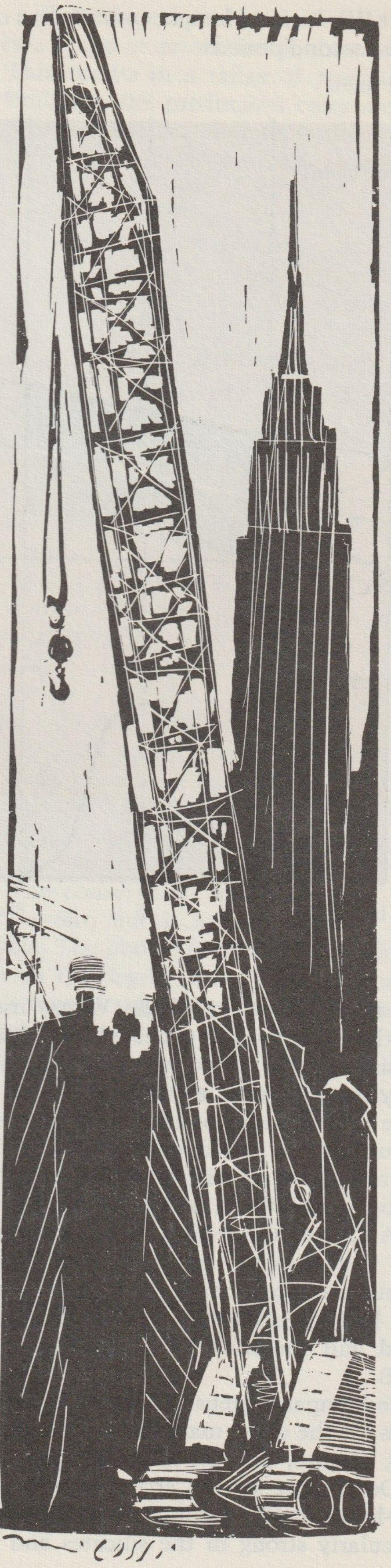
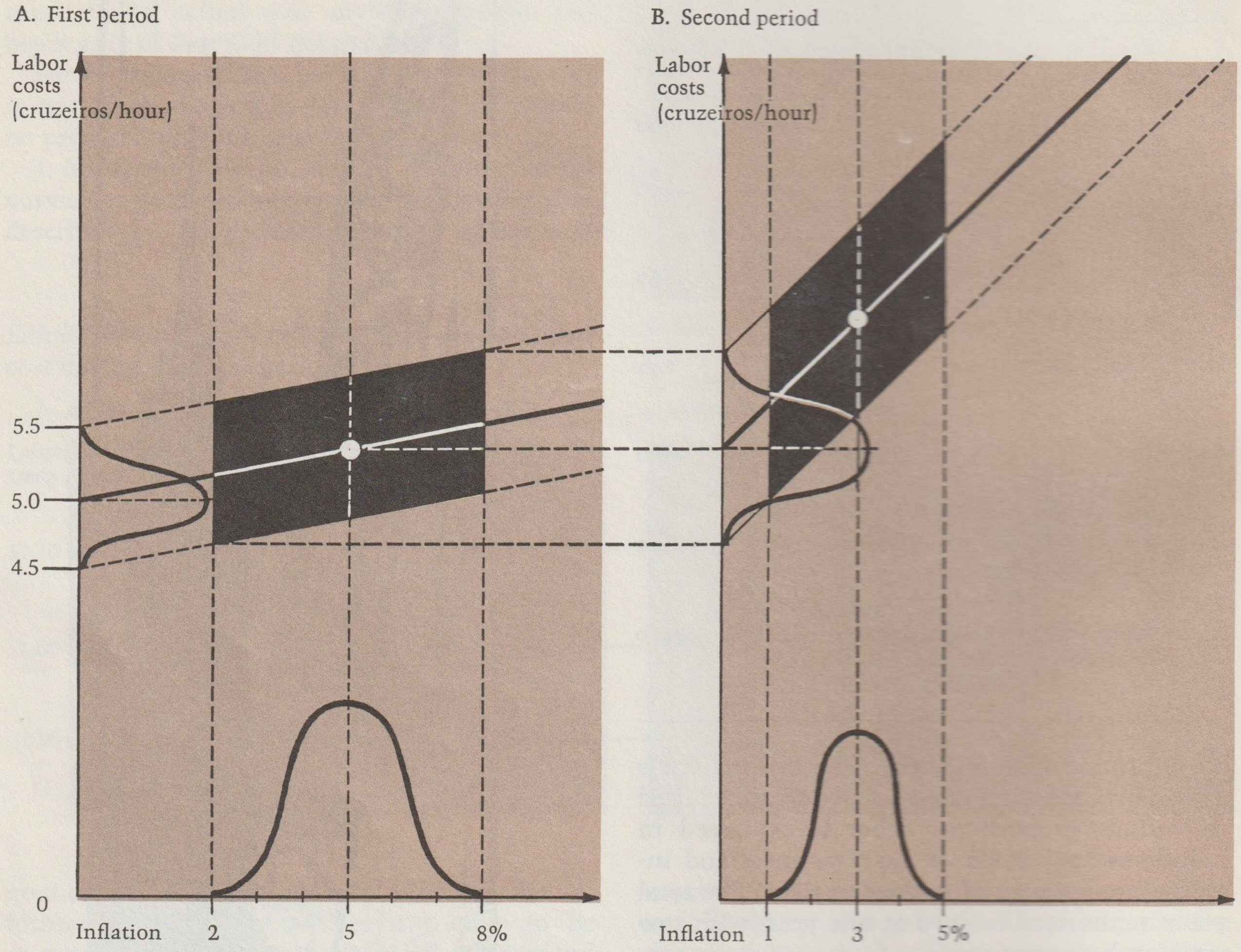


Exhibit VII. Projected impact of inflation on labor costs for the first and second periods



ation in the accuracy of the Vargas index. As the exhibit shows, it is expected that, during the first six months, labor costs will increase more slowly than the total economy.

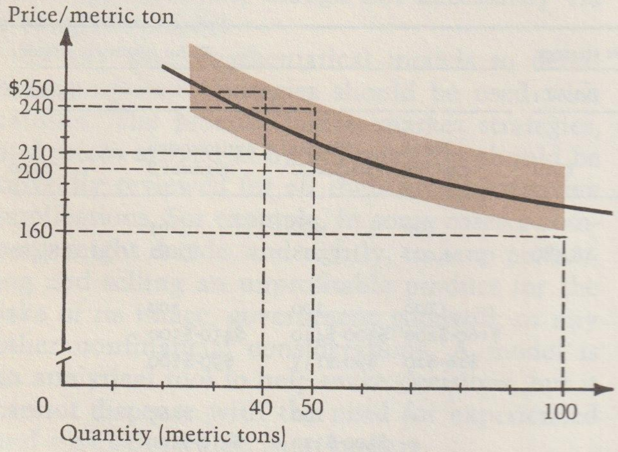
The uncertainties of labor cost at the beginning of the first period, combined with the general inflation rate, will bring the per-hour cost of labor somewhere within the black area of Part A. During the second half of the year, labor costs will increase faster than the prices in the total economy; hence the steeper slope of the main line in Part B. Labor costs for the second period will therefore lie in the black area of Part B.

The company prepares similar inflation/cost charts for the other manufacturing inputs: lead, acids, plastics, fillings, silicates, oxides, and so on. Developing all the charts here is unnecessary—let us merely assume the price rise will be particularly strong in the silicates and plastics, while moderate in lead, lead derivatives, and fillings. Let us also assume that the company does not expect any price changes in the acids and wax, which happen to be imported from very stable markets.

The company demand bands for each product are the last input required. For the flame modifier the demand band for the local market shown in *Exhibit VIII* indicates that about 50 tons can be sold in Brazil, at a price of between $200 and $240 per ton; and that the market would expand to about 100 tons if the price were set between $160 to $200. The demand band is much flatter for the export market (see *Exhibit IX*) because competition is stronger in this market. Finally, we assume that these demand bands will not change during the next year. If they do, the graphs can be redrafted for the two periods.

In this particular example, the decision maker must deal with two special, explicit restraints.

Exhibit VIII. Demand band for flame modifier in the local market



For social reasons, the total labor force cannot be reduced. In addition, the Brazilian government has ruled that hard currency imports shall be less than the exports of the corporation.

Once again, the problem is this: Which products, and in what amounts, should the company produce over the next year, to which market should it direct them, and how should it price them to ensure that inflation does not squeeze out profits?

The solutions

Exhibit X presents two optimal solutions out of the infinite set, a conservative solution and a more aggressive one. Each solution identifies the products to be manufactured in both periods, the total amounts to be produced, the breakdown of this volume for the local and export markets, the sales price, and the resulting revenues. Since the prices are selected from demand bands, rather than demand curves, the model supplies a range of prices rather than an exact price. This results in a range of possible revenues. Similarly, the production costs are given as a range because of the uncertainties of the prices of the inputs. Finally, each solution includes a comparison of total revenues and costs, and the resulting profit range.

The conservative corporate strategy proposes a product mix, a market distribution, and a pricing policy which would result in a total revenue between $344,700 and $400,800, while total costs would vary in the $300,000 to $321,000 range. The lowest possible profit—the one corresponding to the extreme high point of the cost range and the extreme low point of revenues—would be $23,700. The best possible outcome of this strategy is some $100,800. The most likely value would be $62,250.

In comparison, the aggressive solution will result in revenues between $502,700 and $619,500 (a range considerably larger than that in the conservative solution), and costs of $436,000 to $517,100. The extremes of the range of operating results are a loss of $14,400 and a profit of $183,500, with a mean of $84,550.

These two strategies might correspond to Policies B and D, respectively, of *Exhibit II*. The higher expected profit of the aggressive solution is offset by a larger variability in earnings, as one can see by the wide range of possible outcomes. The conservative solution has a lower expected profit, but it is comparatively more predictable. The choice between these solutions depends on the degree of aversion the corporation feels toward risk as expressed by variability in earnings.

Finally, note that the labor content of all the product mixes is identical (18,480 man-hours),

Exhibit IX. Demand band for flame modifier in the export market

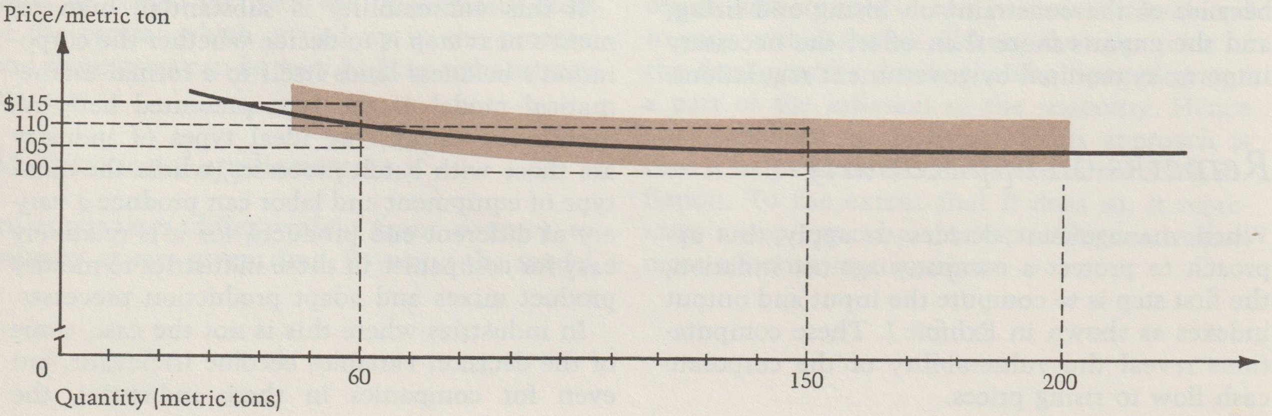


Exhibit X. Two solutions, one conservative and one aggressive, specifying viable product mixes

	A. A conservative strategy				B. An aggressive strategy			
Period 1	Flame modifier	Plastics stabilizer A	Anti-corrosion pigment B	Total	Flame modifier	Plastics stabilizer C	Anticorrosion pigment B	Total
Total quantity (tons)	200	100	200		100	400	265	
Labor input (man-hours)	8,800	3,520	6,160	18,480	4,400	5,918	8,162	18,480
Local market								
Quantity (tons)	50	40	100		100	300	200	
Price/ton	$200-$240	$100-$110	$500-$600		$160-$200	$300-$450	$450-$500	
Revenue ($000's)	$10-$12	$4-$4.4	$50-$60		$16-$20	$90-$135	$90-$100	
Export market								
Quantity (tons)	150	60	100		—	100	65	
Price/ton	$100-$110	$100	$450-$500		—	$300-$320	$450-$500	
Revenue ($000's)	$15-$16.5	$6	$45-$50		—	$30-$32	$29.2-$32.5	
Total revenue ($000's)	$25-$28.5	$10-$10.4	$95-$110		$16-$20	$120-$167	$119.2-$132.5	
Total cost ($000's)	$20-$22	$8-$9	$80-$85		$10-$11	$80-$138	$106-$112.6	

Period 2	Flame modifier	Plastics stabilizer B	Total	Anticorrosion pigment B	Total
Total quantity (tons)	100	500		600	
Labor input (man-hours)	4,400	14,080	18,480	18,480	18,480
Local market					
Quantity (tons)	40	200		450	
Price/ton	$210-$250	$400-$500		$400-$500	
Revenue ($000's)	$8.4-$10	$80-$100		$180-$225	
Export market					
Quantity (tons)	60	300		150	
Price/ton	$105-$115	$400-$450		$450-$500	
Revenue ($000's)	$6.3-$6.9	$120-$135		$67.5-$75	
Total revenue ($000's)	$14.7-$16.9	$200-$235		$247.5-$300	
Total cost ($000's)	$12-$15	$180-$190		$240-$255.5	

	A. Periods 1 and 2	B. Periods 1 and 2
Total revenue ($000's)	$344.7-$400.8	$502.7-$619.5
Total cost ($000's)	$300-$321	$436-$517.1
Total profit ($000's)		
Range	$23.7-$100.8	($14.4)-$183.5
Mean	$62.25	$84.55

because of the constraint on hiring and firing; and the exports more than offset the necessary imports, as required by government regulations.

Remarks on applicability

When management decides to apply this approach to protect a company against inflation, the first step is to compute the input and output indexes as shown in *Exhibit I.* These computations reveal the vulnerability of the corporate cash flow to rising prices.

If this vulnerability is substantial, management's next step is to decide whether the corporation's business lends itself to a formal mathematical model of the type presented here. As mentioned earlier, the ideal types of industry are those with batch processes, where the same type of equipment and labor can produce a variety of different end products, for it is relatively easy for companies in these industries to modify product mixes and adapt production processes.

In industries where this is not the case, some of the decision variables become irrelevant; but even for companies in these industries, the pricing and the import-export decisions can still be complex enough to warrant formal input-output analysis, though not necessarily via a computer model.

In any case, mathematical models to determine corporate strategies should be used with caution. The product mixes, market strategies, and prices arrived at by optimization should be carefully reviewed for all their nonquantitative implications. For example, in some cases a company might decide, and rightly, to keep producing and selling an unprofitable product for the sake of its image, government goodwill, or any other nonfinancial considerations. A model is an analytical tool to help make decisions, but it cannot dispense with the need for experienced and sophisticated decision makers.

One should also keep in mind that product management is only one of the areas affected by inflation. At least two other functions should be reviewed: financial management and inventory policies.

Classical financial management, particularly cash management, breaks down under runaway inflation, and much tighter control is required to avoid the erosion of working capital. A company can do this by scheduling the loan transactions of the company more precisely, pledging or factoring of receivables, changing credit terms to customers, stretching payables, and other financial transactions. I have developed a short-term cash management model which helps determine a coherent cash strategy for a corporation in a highly inflationary environment, but this is not the place to dig into the details of this technique.

The other area requiring serious reconsideration when inflation builds up is inventory management. One method of reducing the impact of inflation is to stockpile supplies and inventories on which the cost is expected to rise in the future. However, the benefits of stockpiling must be traded off with the opportunity costs of the capital which is tied up in the process, and these costs can be very high in tight money markets.

Multinational applications

Inflation rates differ widely from country to country at any given time. By using the model I have described here, corporations with a number of production and marketing facilities in different countries could take advantage of these inflation differentials.

Few corporations take formal account of differential inflation rates for strategic planning purposes. If the chemical company just described in detail operates in Chile and in Brazil simultaneously, and if the inflation on lead is less in Chile, it could pay off to produce the flame modifier in Chile for both markets and export the required quantities to Brazil. Incidentally, a number of financial institutions (as distinct from corporations) have already learned how to take advantage of such differentials and have shown the substantial benefit which can be obtained from it.

The model presented in this article can be readily expanded to include production facilities in a large number of countries and to optimize the production location for each product, while taking into account differential inflation rates, transportation costs, regulations for exporting from any country to any other, and related foreign exchange controls, as well as the company's productive and marketing capacities in the different locations.

Conclusion

The approach I have outlined here is one of the first applications of operations research to improve management in an environment of rising prices. It is a powerful tool which provides some new insights and solutions to the complex problems raised by inflation. The new computer model helps to select coherent product mixes, manufacturing processes, market strategies, and prices which safeguard a company's profits from inflationary erosion.

Changes in product mixes, production processes, and sources of raw materials introduced to cope with inflation all keep the sales price of the final product down, thereby "mopping up" a part of the inflation of the economy. Hence one important implication of this approach is that it helps business contribute to reducing inflation. To the extent that it does so, it represents a step toward more responsible, as well as more effective, management.

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