

Some Simple Propositions Concerning Cost-Push Inflation

The government's wage-price guidepost policy is predicated on the assumption that firms in basic industries possess discretionary pricing power. But this assumption in itself does not suffice to justify government intervention in steel, copper, and aluminum pricing decisions. The case for intervention rests on the presumption that price adjustments in those key sectors have a significant effect upon the general price level. Clearly, if wage-price guideposts are to be frequently invoked in an attempt to combat inflation, the task of obtaining quantitative estimates of the inflationary impact of autonomous price and wage adjustments in key sectors of the economy is of critical importance.

How much inflation would have been generated if the price of steel had increased by \$6.00 per ton in 1962? Obviously, the answer to this question must hinge in large measure upon the response of wages, profit markups, and prices in other sectors of the economy. In the first section of this paper we estimate the extent of the inflation that would have been generated if the price of steel had increased by \$6.00 per ton in 1962 while the response of other sectors of the economy was constrained by the guideposts. Guidepost policy allows steel-using firms to respond to rising material costs by raising their prices rather than reducing their profit margins; similarly, the customers of steel-using firms may pass along their costs, and so on to the eventual consumer. On the other hand, the guide posts do not permit money wage rates to adjust in response to rising prices.¹ If the price response of steel-using sectors and labor are not governed by the guideposts, our initial estimate of the inflationary effect of a \$6.00 increase in the price of steel must be modified. Section II considers the implications of certain sectors absorbing cost increases from profit margins rather than passing them along to their customers. Section III evaluates the effects of induced markup and wage increases that violate the guideposts.

Our estimates are based on a series of quite general propositions that can be employed for estimating the inflationary effects of autonomous price and wage adjustments in any sector. In deriving these propositions, we employ the input-output approach developed by Wassily Leontief [2] for analyzing price movements. This approach takes into account both the direct purchases of steel and the steel content of other purchased inputs in evaluating the effect of a change in the price of steel upon production costs in other industries. This same procedure was utilized by Otto Eckstein and Gary Fromm [1] in their analysis of the contribution of steel to the inflation of the 1950's. In contrast to Eckstein and Fromm, however, we shall employ the implicit GNP price deflator as a gauge of movements in the general price level. The complicated input-output procedure reduces to a matter of quite simple computations once the GNP deflator rather than the wholesale price index is selected as the gauge of movements in the general price level.²

¹ Wage increases under the guideposts are equal to the trend rate of over-all productivity increase, which can be regarded as exogenous in analyzing the incremental effects of autonomous price adjustments. On the other hand, firms are permitted to raise prices in response to increases in nonlabor costs. Cf. [5, p. 189].

² A disadvantage of the wholesale price index as a measure of inflation arises from the excessive weighting that it gives to such commodities as steel, because commodities enter the index repeatedly at successive stages of the production process. The GNP deflator has considerably broader coverage, including services and construction. While the GNP index has limitations as a measure of long-run price movements because of difficulties involved in making appropriate adjustment for quality improvements, this limitation is not critical when the objective is to measure the incremental effect on the general level of prices of autonomous price and markup changes. An advantage of the GNP deflator is that it is based upon current quantity weights.

I. *The Basic Proposition*

We shall establish the following proposition:

The impact upon the GNP implicit price deflator of an autonomous increase in the gross profit margin of a particular industry may be approximated by dividing GNP into the product of the change in the margin times the level of gross output for that industry, provided that gross profit margins in other sectors and wage rates are unaffected.

This proposition suggests that if the steel industry had raised prices by \$6.00 per ton in 1962 (an increase of approximately 3.8 per cent), it would have raised the general price level as measured by the GNP deflator by only one-tenth of one per cent,³ that is, since 98.3 million tons of steel were produced in that year and GNP was \$553.9 billion,

$$\frac{\Delta p}{p} = \frac{\$6.00 \times 98.3 \text{ million tons}}{\$553.9 \text{ billion}} = 0.001065 \quad \text{or} \quad 0.1065\%.$$

Although this figure may appear small, there are several reasons why it probably overstates the inflation that would be generated by a rise in the price of steel if firms in other sectors of the economy and labor abided by the guideposts. We shall see that the derivation of our basic proposition requires the assumption that the composition of final demand and the input-output coefficients are insensitive to moderate changes in relative prices. In utilizing the final bill of goods that was actually purchased in the absence of the steel price rise in this calculation we are in effect employing a Laspeyres price index, and thus exaggerating the effects of the price increase.⁴ The assumption of fixed technological coefficients also contributes to an overstatement of the inflationary impact of an increase in the price of steel.⁵ Furthermore, the proposition refers to a gross profit margin rather than to a price increase; consequently, it leads to an overstatement of the effects of a \$6.00 per ton increase in the *price* of steel to the extent that the price adjustments permitted of other sectors under the guideposts, by increasing the

³ This is an estimate of the *incremental* effect upon the general level of prices of an increase in the steel margin. The actual change hinges upon how a host of inflationary and deflationary forces balance out. The implicit price index increased from 115.8 to 116.7 (1954=100) from 1961 to 1962, and our estimate is that the index would have stood at 116.8 if the price of steel had increased by \$6.00 per ton in 1962.

⁴ The GNP deflator is a Paasche index; it uses current rather than base-period weights. But since the \$6.00 per ton increase was not maintained, our measure utilizes weights in the absence of the price change, and is Laspeyres in the sense in which the term is used by welfare economists. More technically, prices are weighted in the GNP deflator in accordance with the actual composition of final demand (the final bill of goods); if the price increase had been maintained, the application of our proposition would have yielded the change in a Paasche index because the weights would have reflected the shift in the composition of final demand induced by the price change.

⁵ A hypothetical example will illustrate the necessity of assuming fixed technological coefficients. If aluminum and steel were essentially perfect substitutes, and if relative prices were such that steel-users were on the borderline of indifference between using aluminum rather than steel, a \$6.00 per ton increase in the price of steel would precipitate the general substitution of aluminum for steel without any material impact upon the price of final product.

costs of raw materials in the production of steel, prevent a full \$6.00 per ton increase in the steel margin.

In demonstrating the validity of our proposition it is convenient to employ matrix algebra. Let $P = [p_i]$ denote the row vector of industry prices, $A = [a_{ij}]$ an input-output matrix of technological coefficients a_{ij} , revealing the quantity of good i required to produce a unit of gross output of good j , $M = [m_i]$ a row vector of gross profit margins, $L = \text{diag}(l_i)$ a diagonal matrix of labor coefficients indicating the amount of labor of the i th type necessary to produce one unit of the i th commodity, and $W = [w_i]$ a row vector of industry wage rates.⁶ Then the matrix equation

$$(1) \quad M = P - PA - WL$$

defines the gross profit margin of each sector as the difference between price and unit material and labor costs. Thus, the gross profit margin includes capital consumption allowances and indirect business taxes. From this expression it is apparent that given industry markups, wages, and the matrices A and L , the vector of sector prices may be determined by calculating

$$(2) \quad P = (M + WL)(I - A)^{-1}.$$

The GNP deflator is obtained by dividing GNP in current dollars by the value of final outputs measured by prices in the base period. Let the column vector $Y = [y_i]$ denote the final bill of goods whose components reveal for each commodity i the sum of investment, consumption, government spending, and the excess of exports over imports. Provided that trade, construction, etc., have been included as sectors in addition to manufacturing, GNP is simply PY , and the GNP deflator may be denoted by:

$$(3) \quad p = PY/P^0Y,$$

where the superscript indicates, in general, that the variables refer to the base period. Utilizing (2) in conjunction with the fundamental equation of input-output analysis, $Y = (I - A)X$, yields:

$$(4) \quad PY = (M + WL)(I - A)^{-1}(I - A)X = (M + WL)X;$$

this states that GNP is identical to the sum of value added by each industry. Substituting (4) into (3) and differentiating with respect to m_i , the i th industry's profit margin, we have:

$$(5) \quad \frac{\partial p}{\partial m_i} = \frac{x_i}{P^0Y}.$$

⁶ Our basic proposition does not require the use of an estimated input-output matrix. This means that exogenous changes in the input-output and labor utilization coefficients as a result of such factors as technological change offer no difficulties, although we do require that the coefficients be insensitive to moderate changes in relative prices and wages. Note too that empirical considerations do not restrict the number of sectors, no problem of aggregation confronts us, and in principle we could regard quantities as measured in conventional physical units (e.g., tons of steel and hours of labor); alternatively, of course, the output of each sector can be measured in terms of prices in a base period, the units of measure being dollars, as is customary in empirical input-output applications.

Because the model is linear,

$$(6) \quad \Delta p = \frac{x_i \Delta m_i}{P^0 Y},$$

which is our basic proposition. As a convention, it is convenient to adopt as the base P^0 the level of prices that actually would have prevailed in the absence of the margin change, hence, $100\Delta p$ is the percentage increase in the GNP deflator generated by the increase in the profit margin.

It is interesting to contrast the simplicity of (6) with the computations undertaken by Eckstein and Fromm [1] in their input-output analysis of the inflation of the 1950's. While they also assume that wage rates and profit margins in other sectors of the economy are unaffected by steel-pricing policy, they employ the wholesale price index rather than the GNP deflator. With this approach they have, instead of our equation (4), the expression:

$$(7) \quad PQ^0 = (M + WL)(I - A)^{-1}Q^0,$$

where Q is a column vector of weights in the wholesale price index. The level of the index, then, is

$$(8) \quad p_w = \frac{PQ^0}{P^0Q^0} = \frac{(M + WL)(I - A)^{-1}Q^0}{P^0Q^0}$$

and

$$(9) \quad \Delta p_w = \frac{c_i Q^0}{P^0 Q^0} \Delta p_i,$$

where the vector c_i is the i th row of $(I - A)^{-1}$. The implementation of this approach requires a reconciliation of the wholesale price index classification with that of an empirically estimated input-output matrix of flow coefficients, the inversion of $I - A$, and computation of the inner product of the vector of price index weights times the steel row of $(I - A)^{-1}$. This approach, unlike ours, is sensitive to errors in measuring the input-output coefficients.⁷

Charles L. Schultze [4] has employed a national-income-accounting framework which facilitates the comparison of industry price and cost movements with changes in the GNP deflator. He has emphasized [4, pp. 19, 52] that his detailed tables presenting the contribution of various sectors of the economy to changes in the general price level for the 1947-57 period should be given an accounting rather than a "casual" interpretation. Since his tables are based on a formula equivalent to that stated in our basic pro-

⁷ Eckstein and Fromm argued that if it had not been for the "extraordinary behavior of steel" the wholesale price index would have risen by 14 rather than 23 points from 1947 to 1958. This does not imply, however, that the application of their procedure would yield an estimate of the inflationary effect of a \$6.00 increase in the price of steel in 1962 grossly different from ours. The \$6.00 increase that generated so much excitement in 1962 was much smaller in magnitude than the steel price increases that occurred in the decade examined by Eckstein and Fromm.

position, our analysis suggests that precisely the same assumptions as those specified in this paper and by Eckstein and Fromm would have to be satisfied before Schultze's calculations could be regarded as indicating the extent to which various sectors have caused inflation. Specifically, changes in profit margins and money wage rates must be exogenous and, in addition, the technological coefficients must be insensitive to moderate changes in relative prices.⁸

II. Cost Absorption

If, as is sometimes alleged, firms in certain sectors of the economy exercise discretionary pricing power rather than responding promptly to changing demand and cost conditions, it seems probable that these same firms may choose partially to absorb cost increases, at least temporarily, rather than pass them along to their customers through higher prices. In these circumstances, the inflationary impact of an increase in a basic industry's markup upon the general price level will be reduced or delayed. We shall show:

When some industries absorb cost increases, while the remaining industries preserve profit margins in the face of changing costs, the inflationary impact of an autonomous increase in the gross profit margin of a particular industry is governed by the proportion of that industry's total output not required, directly or indirectly, by the cost-absorbing industries.

To verify this assertion, which constitutes the price-dual of Paul Samuelson's application of the LeChatelier Principle to input-output models [3], let us suppose, as a matter of notational convenience, that the first n_1 sectors adjust prices in order to preserve profit margins while the remaining $n_2 = n - n_1$ sectors absorb cost increases. Let us consider the $n \times n$ matrix A of input-output coefficients in partitioned form:

$$A = \begin{bmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{bmatrix},$$

where the submatrix A_{11} is of dimension $n_1 \times n_1$, A_{12} is $n_1 \times n_2$, etc.; similarly, we partition $P = [P_1; P_2]$, and so forth. The matrix equation explaining prices in the margin-preserving industries is

$$(10) \quad P_1 = P_1 A_{11} + P_2 A_{21} + M_1 + W_1 L_1$$

$$(11) \quad = (P_2 A_{21} + M_1 + W_1 L_1)(I - A_{11})^{-1}.$$

Since the last n_2 sectors are cost absorbers, the vector P_2 is exogenous. If we let the n_1 component column vector $X_1^* = [x_i^*]$ denote $(I - A_{11})^{-1} Y_1$, the market value of all goods and services produced in the economy is

$$(12) \quad PY = P_1 Y_1 + P_2 Y_2 = (P_2 A_{21} + M_1 + W_1 L_1) X_1^* + P_2 Y_2$$

$$(13) \quad = P_2 (A_{21} X_1^* + Y_2) + (M_1 + W_1 L_1) X_1^*.$$

⁸ See footnote 5.

Substituting this last expression into equation (3) yields a new expression for the GNP deflator:

$$(14) \quad p = \frac{P_2(A_{21}X_1^* + Y_2) + (M_1 + W_1L_1)X_1^*}{P^0Y}.$$

If one of the first n_1 (margin-preserving) sectors autonomously adjusts its profit margin, the GNP deflator will obviously change by

$$(15) \quad \Delta p = \frac{x_i^*}{P^0Y} \Delta m_i, \quad (i = 1, 2, \dots, n_1).$$

This is smaller than our original estimate of the inflationary impact of a markup change by the proportion x_i^*/x_i —the fraction of the actual gross output of the markup increasing sector that is not used, directly or indirectly, by cost-absorbing industries in the production of the final bill of goods. On the other hand, the sector initiating the inflation may be a cost-absorber; that is, it increases its price and allows any subsequent induced cost increases to erode its gross profit margin. From (14) we see that in this case

$$(16) \quad \Delta p = \frac{x_i^{**}}{P^0Y} \Delta p_i, \quad (i = n_1 + 1, \dots, n),$$

where

$$x_i^{**} = \sum_{j=1}^{n_2} a_{ij}x_j^* + y_i$$

is the i th element of the column vector $X_2^{**} = A_{21}X_1^* + Y_2$. The quantity x_i^{**} is that component of x_i that is not used, directly or indirectly, by cost-absorbing industries.

In utilizing our first proposition to estimate that the effect of a \$6.00 increase in the price of steel would raise the GNP deflator by 0.11 per cent if all other sectors observed the guideposts, we were neglecting the possibility that the rise in prices precipitated by this action might raise the costs of inputs to steel and prevent the margin on steel from rising by a full \$6.00 per ton. A \$6.00 price increase under these circumstances means that steel is a cost-absorbing sector, and our estimate overstates the effects of the price increase by the ratio x_i^{**}/x_i , where x_i^{**} is the output of steel that is not used, directly or indirectly, as inputs by the steel industry.

III. Attempts to Preserve Real Shares

Our suggestion that a \$6.00 per ton increase in the price of steel would have raised the general level of prices by about one-tenth of one per cent was based on the assumption that money wage rates and profit margins in other sectors are unaffected by increases in prices, as required by guidepost policy.

In this section we explore the consequence of attempts in other sectors to preserve real wages or profit margins following an exogenous price increase. We begin by considering the effect of attempts by labor in all industries to maintain real wage rates. We will show that:

If all money wage rates adjust to the increase in the cost of living, the original inflationary impact of an increase in the gross profit margin will be multiplied by the reciprocal of one minus labor's share.

Since labor's share in U. S. output is roughly three-fifths, the inflationary impact of a \$6.00 per ton increase in the price of steel would have been about 0.27 per cent instead of the 0.11 per cent, if all wages adjusted to the price increase.

This revised estimate relies on the assumption that movements induced in the cost of living index are about the same as the changes in the implicit GNP deflator so that the vector of industry money wages is:

$$(17) \quad W = pW^0,$$

where the scalar p is again the GNP deflator and W^0 the vector of initial money wage rates. Substituting (17) into equations (4) and (3) yields:

$$(18) \quad PY = (M + pW^0L)X,$$

and

$$(19) \quad p = \frac{(M + pW^0L)X}{P^0Y}.$$

Hence,

$$(20) \quad p = \frac{MX}{P^0Y - W^0LX} = \frac{MX}{P^0Y} \left(\frac{1}{1 - \lambda} \right)$$

where

$$\lambda = \frac{W^0LX}{P^0Y}$$

denotes labor's share.

The inflationary effect of a change Δm_i in the markup of sector i is therefore:

$$(21) \quad \Delta p = \frac{x_i \Delta m_i}{P^0Y} \left(\frac{1}{1 - \lambda} \right).$$

If only certain portions of the labor force maintain real wage rates as prices rise, λ in equation (21) corresponds to that fraction of GNP represented by their money wages.

More generally, equation (21) reveals the effects of the preservation of real gross profit margins and wages in specific industries, once λ is appropri-

ately reinterpreted.⁹ Suppose, for example, that while labor and producers in the manufacturing sector, other than steel, observe the guideposts, prices and wages in nonmanufacturing sectors adjust so as to preserve real shares. Under these circumstances, the inflationary impact of a \$6.00 per ton increase in the price of steel would be considerably larger than our initial estimate suggested. Since gross product originating in manufacturing is roughly one-third of GNP, $\lambda = \frac{2}{3}$ and a \$6.00 steel markup increase in these circumstances would raise the GNP deflator by approximately:

$$\Delta p = .1065\% \left(\frac{1}{1 - \frac{2}{3}} \right) = 0.32\%.$$

Following the procedure set forth in Section II, this estimate can be adjusted to take account of cost absorption, i.e., deterioration in the real wage or profit margins in various sectors.

IV. Conclusions

Any analysis of cost-push inflation is incomplete, for the concept neglects the fact that price increases reduce real final demand unless offset by expansionary monetary or fiscal policy. Subject to this limitation, the propositions set forth in this paper provide a simple method for obtaining quantitative estimates of the inflationary effects of autonomous price increases, once the responses of other sectors are specified.

The extent to which a departure from the guideposts actually contributes to inflation depends upon both the magnitude of the violation and the sensitivity of the general price level to price adjustments made by the sector deviating from the rules of noninflationary behavior. We estimate that a \$6.00 increase in the price of steel in 1962 would have raised the GNP deflator by less than 0.11 per cent, *if* labor and firms in other sectors of the economy had observed the guideposts. This suggests that violations of the administration's guideposts by so called "key industries" have not in themselves constituted a clear and present danger to price stability.

Autonomous price adjustments that induce other sectors to violate the guideposts have a more substantial effect. For example, we found that the inflationary impact of a \$6.00 per ton increase in the price of steel in 1962 would have been 0.27 per cent if unions negotiated wage adjustments preserving labor's real share. Additional inflation would have been generated if firms in other sectors of the economy were induced to raise their profit margins. This suggests that the case for enforcing the guideposts must be based on the argument that price adjustments in key sectors constitute a danger-

⁹ An increase in a particular sector's margin will cause all prices to rise proportionately if all other sectors adjust their prices so as to preserve their real shares. This result, which is in conformity with classical general equilibrium theory, is derived by observing that in these circumstances equation (20) reduces to $p = MX/m_i^0 x_i$, where i denotes the sector attempting to increase its margin, the only sector that suffers from money illusion. If no sector suffers from money illusion, $\lambda = 1$ and prices will rise indefinitely as the result of a sector's attempt to raise the real value of its margin.

ous precedent which will generate inflation by precipitating wholesale violation of the rules of noninflationary price behavior.

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