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The Impacts of Inflation on Agriculture

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Table of Contents

Abstract

The Impact of Inflation on Financial Activities in Agriculture

1. Interest on working capital for a process
2. Interest on working capital for a firm
3. Income measurement
4. Liquidity aspects of investments
5. Costing and pricing assets' services
6. Effects of inflation on tax liability
7. Effects of inflation on price variability

Implications for policy

Description of Cooperation

Benefits to Agriculture

List of Publications

Abstract

Real and monetary activities do not behave similarly under inflation. While monetary returns are generally inflation-compensated within the transaction period, real activities generally make use of fixed assets as well as monetary assets and the return on the former usually do not realize the full amount of the inflation-compensation in the same period. This aspect, along with conventional tax rules and financial practices render inflation impact on financial activities to be non-neutral. Furthermore, inflation causes uncertainty in prices of inputs and outputs. Analyzing financial activities under neutral inflation hypothesis, as is often currently practiced, leads to distorted results regarding costing and pricing, investment evaluation, income measurement, and performance evaluation.

The present study tries to reconcile the treatment of inflation-adjustments of costs and assets with those of income and liabilities. Specifically, the report develops the required models and procedures for 1) correct costing and pricing, 2) measurement of operating income and capital gains, 3) the real cost of working capital and that of other assets, and 6) the marginal deterioration of the financial liquidity in debt financing due to inflation and taxes. In addition to the impact of inflation on firms' activities, high inflation was found to significantly increase the level of uncertainty in supply and demand relationships.

The models discussed in this study have been applied to measure the impact of inflation on various aspects of financial activities in Israel and the U.S.A.

THE IMPACT OF INFLATION ON FINANCIAL ACTIVITIES IN AGRICULTURE*

Y. Goldschmidt, L. Shashua and J.S. Hillman

This report represents the final exposition of a two year research project which was directed toward analyzing the impact of inflation on financial aspects of agricultural activities, at both the farm and sector levels. The findings are intended to serve a wide audience of firms, professionals and policy-makers, especially in the field of agriculture.

Studies of financial analysis under inflation are not new, and much has been published on the subject. Yet, many conclusions arrived at by using the existing analytic procedures at the level of the individual firm are inconsistent with reality at the level of the entire industry, or of a sector. For example, take the case of business taxation and earnings: Business income is taxed on a nominal basis, thus inflation is expected to lead to overtaxation of business firms, to an erosion in equity, and to a decline in real earnings. In reality, however, in many countries which suffer from persistent inflation, the tax share taken from business declines considerably, while capital gains and equity show a real increase. This has a significant propensity toward accelerating inflation. Another notable example is the negligible importance given thus far by many analyses to financial liquidity and to its effect on the activities of business firms during inflation.

The failure to draw correct conclusions at the level of the business firm which are consistent with the sector's reality, and the lack of consistent results between ex-post and ex-ante activities lies mainly in the fact that

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the role of the interest rate in particular, and the liability side of the balance sheet in general, have been treated at variance with the costs and the assets side of the balance sheet. This subject matter forms the theme of this report. The report presents models and procedures treated in this study (seven topics) and some major results of application on U.S.A. and Israel data.

1. Interest on Working Capital for a Process

Interest expenses on working capital are relatively an insignificant factor in budgeting and costing agricultural crops and enterprises as long as the interest rates are low. However, when interest is high, as happens in time of inflation, the cost of working capital for prolonged agricultural production processes becomes a significant item. For example, when the interest rate is 20 percent per annum, the cost of working capital for cotton in Arizona is estimated to be 7.5 percent of gross income.

Another way inflation affects operating costs is the so-called "efficiency illusion" in relating costs to gross income. The costs (excluding interest), which are usually expended in the course of the production process, are often related to gross income received at the end of the process, at which time the price level is higher. Thus, the higher the price increase during the production process, the lower the ratio of costs to gross income, and the higher the ratio of interest on working capital to gross income.

The interest expense on working capital usually increases by more than the inflation factor for the following reasons:

- 1) The values of the items composing the working capital, such as inventories, goods in process and receivables, increase with inflation.
- 2) The interest rate increases during inflation usually by the

inflation factor; in a fully anticipated inflation, the interest rate is expected to follow the Fisher hypothesis:

$$r = (1 + r^*) (1 + p) - 1 = r^* (1 + p) + p \quad (1)$$

where r = inflation-compensated interest,

r^* = pre-inflation interest rate,

p = inflation rate.

3) In a dynamic firm, some growth in output is expected which requires additional working capital.

For these reasons, during inflation the interest expense on working capital becomes a significant factor in costing and pricing.

The effect of inflation on the level of interest on working capital is analyzed on two farm activities, cotton and beef herd, using USDA-ESCS (1981a) production budgets for Arizona in 1979. The analysis is carried out by simulating annual inflation rates for the range between zero and 50 percent, for all variables.¹

Two ratios are computed: interest on working capital to gross income, and total costs (excluding interest) to gross income. The effect of inflation on these ratios, for the two farm activities, is presented in Figures 1 and 2. The curves show that inflation radically affects the ratios; however, the ratios for cotton are affected much more than those for the beef herd because the former's need for working capital is significantly larger relative to its gross revenue.

The curves in Figure 1 show that the ratio of interest on working capital rose in accordance with the increase in the inflation rate. Under an inflation rate of 14 percent (approximately the actual 1979 rate in the U.S.), the ratio of interest on working capital to revenue was about 6 percent and 3 percent for cotton and the beef herd, respectively. The curves in Figure 2

show that the ratios of costs to gross income declined concurrently with the increase in the inflation rate, causing an "efficiency illusion." By adding the two ratios together, however, one arrives at a figure more or less constant at all inflation rates.

In summary, during a period of inflation, the nominal needs for, and the cost of, working capital are higher than during a period of constant prices. However, the ratio of working capital to costs is not affected by inflation. In other words, the volume of finance allocated for working capital in agriculture must be adjusted in accordance with changes in the price level of the inputs.

The interest rates in a period of inflation embody a compensation for the expected decline in the purchasing power of the loan's principal. This causes nominal interest expenses to increase by more than the inflation rate. In turn, the ratio of interest expense to gross income increases, while the ratio of other inputs (the recorded historical costs) to gross income is understated.

2. Interest on Working Capital for a Firm

The interest on working capital for a firm plays an important role in the measurement of operating income during a period of inflation. This is because not all the interest expense should be considered as a cost of production. Therefore, correct estimate of the interest on working capital plays a crucial part in analyzing financial activities under conditions of inflation.

The interest on working capital for a firm cannot be estimated directly by aggregation over the firm's various production processes. The reasons are that the accounting period does not coincide with the production cycles of the individual processes, and because the cash surplus of one process can be used to finance the needs for working capital of other processes.

Usually, a firm should estimate the interest on working capital from the period's (monthly) cash flow. This entails appropriate accounting and extensive calculations. To overcome this problem, investigation was carried out to relate actual interest expenses from cash flow data to different estimates derived from financial statements. The analysis was carried out on kibbutzim data in the period 1982-83.

The analysis indicates that the interest on working capital, as derived from financial statements, is mainly affected by the level of current assets, by the average annual interest rate paid, and by the cash surplus of the firm. The analytical function is as follows:

$$I_C = I_L \frac{W_{t-1} + W_t - C(s_{n,i}/n)}{L_{t-1} + L_t} \quad (2)$$

where I_C = interest on working capital,

C = cash surplus as shown below,

$$s_{n,i} = \frac{(1+i)^n - 1}{i} = \text{future value of an ordinary annuity,}$$

i = periodic (monthly) interest rate on short-term loans,

n = periods in a year (months),

$C(s_{n,i}/n)$ = cash surplus plus earnings thereon.

The cash surplus can be estimated as follows:

$$C = \text{Sales} - \text{COGS} - I_F - \text{IN} \quad (3)$$

where $\text{COGS} = \text{Purchases} + \text{INVY}_{t-1} - \text{INVY}_t$

= cost of goods sold exclusive of depreciation,

INVY = inventories at replacement value,

I_F = interest expenses on loans financing fixed assets,

IN = investment for replacing the existing assets, which can be estimated by the depreciation charges at replacement cost.

The multiplier of the cash surplus can be estimated as follows, when $n = 12$ and for moderate interest rates:

$$s_{n,i}/n \cong \sqrt{1+r} \cong r/2 \quad (5)$$

where r = annual interest rate on short-term loans.

If the cash surplus is not evenly distributed, and there is information on the pattern of the actual flow of cash surplus, the multiplier of C in Relation (3) should be adjusted accordingly.

This function was applied to the U.S. farm sector for the period 1950-1982. Until 1979, the average interest rate actually paid on short- and medium-term loans was relatively low (5-9%), thus, the estimates of interest charges on working capital were approximately 2 percent of the gross receipts. But beginning with 1979, the interest rate rose considerably and the estimates of the interest on working capital jumped to about 4 percent of gross receipts.

To receive an approximate figure of the interest on working capital in the U.S. farm sector, the following regression has been estimated, using data for the period 1950-1982:

$$I_C = 0.775 \ r \ W \quad (5)$$

where I_C = interest expense on working capital as percentage of gross receipts as estimated by Relations (2) to (4),

W = working capital, at the beginning of the year, as percentage of gross receipts,

r = nominal interest rate on short- and medium-term loans.

The correlation coefficient is 0.946, highly significant ($t = 4.05$), and the standard error of estimate is 0.166 percentage points relative to gross receipts.

The specific aspect of the empirical function is that the interest on working capital is not determined by the full amount of the opening balance of the working capital. As the working capital revolves and generates cash surplus, part of the latter helps to finance the former. Therefore, the interest on working capital is not rW , but rather $0.775 rW$. For example, if $W = 0.40$ and $r = 0.11$, then the interest on working capital is not $0.40 \times 0.121 = 0.048$, but rather 0.036 . This is because only 77.5 percent of the working capital (in the U.S. case) bears the full burden of interest and the rest is provided by the cash surplus.

3. Income Measurement

Inflation affects a firm's reported income in two opposite directions: One effect is that the recorded values of assets (fixed and current) and the derived costs (depreciation and purchased inputs) are understated, because these are recorded at historical costs. The other effect is that the interest expenses include a premium or inflation-compensation for the decline in the purchasing power of the loan's principal. This premium is, as a matter of fact, a principal repayment but it is recorded as a cost, causing the costs to be overstated.

The total real income figure includes some items, namely, adjustments of values from the balance sheet, which are not under the control of the firm or sector for which income is measured and also are not realized during the accounting year. To arrive at an income measure that can be used for performance evaluation, the non-controllable items should be reported separately. Thus, total income is broken down into operating income, which has a similar meaning to the pre-inflation net income figure, and capital gains, which result from price-level impacts on balance sheet items.

For calculating the operating income, the nominal interest expenses,

which represent the service of debt, must be adjusted so as to align with the adjustment of the costs representing the services realized from the assets. Thus, charging depreciation at real values (on revalued fixed assets) implies charging real or inflation-adjusted interest on loans that finance the fixed assets. A similar procedure can be applied to the costs related to current assets (purchased inputs) and interest on the corresponding loans, by adjusting both costs and interest expense. However, this procedure involves adjustments of large amounts of data (periodical purchases) which usually are not available. Therefore, we propose to refrain from these adjustments, and instead, to charge nominal interest on working capital in conjunction with the charges of actual historical costs of purchased inputs.

The proposed model delineated below provides similar estimates of total income as measured by other models used in the U.S.A. (USDA, 1983; FASB, 1979) but differs significantly in breaking down total income into operating income and capital gains.

In developing this model, we investigated the properties of two major models used in measuring income in the U.S.A. and Great Britain and found them to be inconsistent and with theoretical pitfalls.²

Measuring total income. The real income of a sector or a firm, in the economic sense, is determined by adding to the income that is reported by the conventional income statement some inflation adjustments of values which are related to balance sheet items, assuming no additions or withdrawals of equity. One possible procedure is to add to the net income the nominal changes in assets' value and to deduct the amount needed to maintain the purchasing power of the equity; that is,

$$R = [\text{SALES} - \text{PURS} - \text{DEPR} - \text{INTR} + d \text{ INVY}] + [d \text{ FIXA} - p \text{ EQTY}_{t-1}] \quad (6)$$

where R = real income

PURS = purchased inputs, recorded value,

DEPR = depreciation on current replacement costs of assets, at year-end prices,

INTR = interest on debt,

INVY = inventories at current replacement value,

FIXA = fixed assets, depreciated current replacement value,

EQTY = equity,

$t, t-1$ = date of closing and opening balance sheets, respectively,

p = inflation rate between $t-1$ and t ,

$d\text{ INVY} = \text{INVY}_t - \text{INVY}_{t-1}$,

= nominal change in current replacement value of inventories,
including physical change and price level gain,

$d\text{ FIXA} = \text{FIXA}_t - \text{FIXA}_{t-1} - \text{Net investment}$,

= nominal appreciation of fixed assets,

Net investment = gross investment in fixed assets less depreciation on current replacement cost of assets, the latter stated in year-end prices,

$p\text{ EQTY}_{t-1}$ = equity maintenance = amount required for maintaining the purchasing power of the equity.

The first bracketed part of Relation (6) represented the conventional income statement where the change in the value of inventories, $d\text{ INVY}$, is included in the cost of goods sold. The second bracketed part in Relation (6) represented the adjustments of balance sheet items, assuming that the value of the financial assets is not affected by price level changes.

To simplify the presentation, the above model ignores adjustments on capital transactions carried out within the analyzed year. Such capital transactions are changes in equity, interim dividends, net investments and assets disposals.³ In the case of a firm, these adjustments are needed.

Measuring operating income and capital gains. In a period of inflation, it is important to find the sources of the real total income. The accepted approach is to differentiate between operating income and gains on balance sheet items. The first income component is of special interest because it is under the control of the firm and conveys the same information as the pre-inflation net income. It is therefore vital that the operating income should be calculated correctly, even though some variables must be estimated rather than measured accurately.

To arrive at the operating income, the cost of materials and the interest expense in the income statement (the first four terms in Relation 6) should be differentiated into items that are related to either current assets or fixed assets, as follows

$$OI = SALES - PURS - DEPR - I_C - I_F + d \text{ INVY} \quad (7)$$

where OI = operating income,

I_C = imputed interest on current assets, mainly on working capital, as calculated in Section 2,

$$I_F = r^*(1 + p) \text{ LF}$$

= imputed interest on loans financing fixed assets,

r^* = inflation-free interest rate,

$$\text{LF} = \text{FIXA} - \text{EQTY}$$

= loans financing fixed assets.

Subtracting the operating income (Relation 7) from the total income (Relation 6) provides the capital gains which should be attributed to the equity. Thus the capital gains are equal to

$$\text{CG} = d \text{ FIXA} + p \text{ EQTY}_{t-1} - (\text{INTR} - I_C - I_F) \quad (8)$$

As the level of the individual components of the capital gains does not provide important information, the capital gains can be calculated in practice

as the difference between the total income and the operating income.

The model outlined above has been tested on about 30 kibbutz settlements in Israel (1982-83). The model provides the main tool for analyzing time series performance of the kibbutzim.

The model was also applied to data for the U.S. farm sector for the period 1950-1982, for providing a series of correct estimates of operating income and capital gains. The revised series may be used for policy and research purposes. The revised estimates are presented in Table 1 alongside the USDA-ERS.

4. Liquidity Aspects of Investments⁴

Inflation has a damaging financial effect on investment in fixed assets, whether equity or debt are used for financing. When the investment is financed by equity, inflation-induced equity erosion occurs because income tax authorities recognize only historical depreciation. When the investment is financed by loans, on the other hand, the inflation-induced behavior of the interest expense weakens the liquidity position of the firm.

The interest rate under conditions of inflation embodies compensation on the loss of the loan's purchasing power, which is not a cost item but rather repayment on principal. The periodic repayment of the inflation-compensation causes accelerated repayment of the loan. The appreciation of the asset financed by the loan, on the other hand, is only partially realized in each period through the returns covering current cost depreciation. The difference between the accelerated loan repayment and the nonrealized appreciation of the asset must be financed by interim funds, usually by short-term loans, assuming that the net profit from the investment is not used for financing these needs.

In other words, given that an investment in an asset is fully financed by debt, throughout its life, the difference between the recorded net asset value

(historical value) and the current net asset value (revalued asset) is financed by short-term loans, even though the investment was originally financed by a long-term loan matching the asset's life span.

Under the assumption of neutral inflation on prices, and ignoring the tax effect (see next section) the economic evaluation of an investment leads to the same conclusion whether the prices are stable or changing. However, the net cash flow is greatly affected by the process of inflation. The reason for this is that the periodic earning of the investment grows by the inflation factor--that is,

$$E_t = E_0 (1 + p)^t \quad (9)$$

where E_1 = earning of \$1 investment in period t ,

$$E_0 = a_n^{-1} r = \frac{i}{1 - (1+r)^{-n}} = \text{capital recovery factor for } n \text{ periods and } r$$

pre-inflation rate of return,

The interest on the loans, on the other hand, is supposed to carry inflation-compensation on the principal as well as on interest, and is constant over the term of the loan, assuming constant uniform inflation. The periodic payment on a \$1 installment loan is

$$a_n^{-1} i \quad (10)$$

where i = interest rate on the loan.

For an investment fully financed by a loan, when both have a life span of n , the cash flow (Relation 9) and the loan's service (Relation 10) is demonstrated by the following graph:

The graph shows a negative net cash inflow of the investment in early periods of its life span. Although the investment is balanced over its life span, the negative cash flow must be financed by short-term loans which are repaid by the positive cash flow in later periods, as illustrated below.⁵

Consider a \$1,000 investment that is financed by a \$1,000 installment loan, the cash flow of which is presented in Section A of Table 2. The net present value of this investment is zero, using 23.6 percent discounting rate because the profit is not retained. Calculations of the needs for short-term loans are illustrated in Section B of Table 2. The \$90.09 cash deficit in the first year is financed by a short-term loan, bearing 23.6 percent interest. At the end of the second year, the need for short-term loans is composed of \$90.09 from the previous year plus the interest on it, summing to \$111.35, plus \$25.53 current deficit. The needs in the third year decline because of the cash surplus, and in the fourth year, the short-term loans are repaid.

The cumulative needs increase in the early years, decline later on, and reach zero level at the end of the investment's life because the profit level is zero. To speak in graphic terms, in general, the cumulative needs assume the shape of a bell.

Financial liquidity is an important aspect in evaluating the economic and financial situation of a firm. This is evidenced by the widespread use of both the current ratio (current assets related to current liabilities) in business and financial analysis. For example, the average current ratio for 2,400 companies in all U.S. industries in 1975 was about two, with a distribution between one and four (Foster, 1978, p. 179). A current ratio higher than one indicates that a portion of the current assets is financed by long-term funds, meaning that fixed assets are financed fully by long-term funds (equity and long-term loans).

Consider the investment in Table 2, which was properly financed; that is,

it was originally financed by a long-term loan matching the investment life span. This loan is partially substituted by short-term loans, in the course of the investment's life span, as shown in Section C of Table 2. At the end of the first year, 10 percent of the liabilities financing the fixed asset are of a short-term nature. The share of these loans increased to 26 percent at the end of the third year.

In summary, as a result of the existing financing practices, inflation induces a partial substitution of the long-term loans that originally financed investments by short-term loans. The longer the investment's life span and the higher the inflation rate, the higher this effect of deterioration in the liquidity position of the firm.

5. Costing and Pricing Assets' Services⁶

In inflationary periods, there is a common error of double counting the inflation factor in carrying out economic analyses such as evaluating alternative production processes of different capital intensity, preparing cost budgets and product pricing. Modigliani and Cohn (1979) claim that in inflationary periods, investors capitalize equity earnings at a rate that parallels the nominal interest rate, rather than at the economically correct real rate--the nominal rate less the inflation component. They found that this error, combined with another inflation-induced error, caused under-evaluation of the U.S. stock market during the 1970s. There is evidence that a similar error occurs in costing the services of assets under inflationary conditions, causing over-estimation of cost of production.

The production of a product is profitable in the long run only if the revenue from its sale covers, at least, the replacement of the inputs used in its production. This is presumably the reason for the widespread use of

full-costs in cost accounting and in price setting. Therefore, during a period of inflation, it is expected that businessmen and institutions will be inclined to use current (replacement) costs in costing and pricing products.

The procedure of using current costs (revalued depreciation and market rate of cost of capital) for costing and pricing sounds logical and therefore may be followed by businessmen. This procedure is recommended in professional publications, explicitly or implicitly (e.g., Bailey, 1978, and Symonds, 1982); applied by analysts in preparing cost budgets (e.g., Conlin, 1975, and Hathorn, 1977-1982); and even used by a government agency in reporting cost of production of crops and livestock for a committee of the United States Senate (e.g., U.S. Department of Agriculture, 1981b). If this procedure is followed during inflation, it will double count the inflation factor--once by revaluing the assets and once by including the inflation compensation in the cost of capital.

The return from a \$1 investment in an asset should be i (which is equal, in a zero profit case, to the pre-inflation interest rate). In the case of inflation, this return is indexed. Following the procedure of using current costs, the firm charges $i + p$ per period (which is equal to the inflation-compensated interest rate) and indexes it in subsequent periods. The present value of the perpetual cash flow stream of such a project is

$$\int_0^{\infty} \frac{(i + p) e^{pt}}{e^{rt}} dt = 1$$

where r = discounting rate under zero profit (the internal rate of return),

i = pre-inflation rate of return,

This integral yields

$$\frac{(1 + p)}{r - p} = 1$$

that is, $r = i + 2p$

In practice, only a portion of a firm's investments are ever financed by loans, and only part of the life span produces a negative cash flow. Thus double counting could only occur in an extreme case. Although the case above illustrates an extreme case of 100 percent leverage, it nevertheless indicates conditions at the margin. It is expected, therefore, that the final price will tend more toward the double counting case than otherwise, especially in a growing firm.

6. Effect of Inflation on Tax Liability

It is a known fact that during inflation, the prevailing income tax rules cause equity erosion. Only scant attention has been given in the literature to the effect of debt (interest expenses) on taxation during inflation.⁷ The analysis below indicates that leveraged firms not only can eliminate the erosion of equity but may have a net inflation tax benefit. This phenomenon provides an incentive to increase the financial leverage, thereby worsening the firm's financial position, which in turn raises the liquidity burden (the ratio of short-term loans to long-term loans).

According to the existing income tax regulations, income is taxed after allowance for historical depreciation and interest expense actually paid. The correct net income, however, is arrived at after deducting current depreciation and imputed real interest. In other words, the actual tax liability is determined by

$$D_h + I_a$$

whereas the correct tax liability is determined by

$$D_c + I_r$$

where D_h , D_c = depreciation charges, historical and current, respectively,

I_a , I_r = interest expenses, actual and real, respectively.

The net change in tax liability is therefore

$$(D_h + I_a) - (D_c + I_r)$$

or

$$(D_h - D_c) - (I_r - I_a) \quad (12)$$

where $(D_h - D_c)$ = difference in tax liability due to depreciation,

$(I_r - I_a)$ = difference in tax liability due to interest.

It is interesting to note that the level of the first term in Relation (12) is affected by the assets' life span, whereas the second term is not affected by the loan's term. The application of Relation (12) is illustrated below.

Consider a two-year \$1,000 asset which is financed by a \$1,000 loan at zero real rate of interest. The pre-inflation return on the asset is equal to the interest on the loan. As the real return is zero, the annual gross return of \$500 is equal to the depreciation which is used to reduce the loan. Under inflation of 20 percent per annum, the gross returns (earnings before interest, depreciation and tax--EBIDT) will grow from \$500 to \$600 in the first year, and to \$720 in the second year. These figures are equal to the current cost of depreciation, and are used to repay the loan. The corresponding financial statements for the two years, assuming straight-line depreciation, are presented in Table 3.

As the real income in the example is equal to zero, the income tax liability should also be equal to zero. However, the net change in tax liability calculated according to Relation (12) amounts to -\$13.89 (lower part of Table 3). Hence, the firm will have a tax benefit, in present value terms, of -\$13.89m, where m is the relevant rate of income tax, given that the firm has tax liabilities resulting from its other activities.

The illustration shows that a firm may have net tax benefits due to

inflation, not necessarily experiencing overtaxation as generally viewed. The level of undertaxation depends on many variables such as the level of the financial leverage, the terms of the loans, the assets' life span and the level of inflation.

To estimate the change in tax liabilities resulting from the inflation-tax effects in the U.S. farm sector, data on historical depreciation are needed. Using available data for the period 1960-1974, the net change in tax liability of the U.S. farm sector was slightly overtaxed by the corresponding net tax liability multiplied by the relevant income tax rate.

The level of the net change in tax liabilities resulting from inflation in constant prices declined over the period 1960-1973. One can surmise that this declining tendency continued after 1973 because of the significant increase in the financial leverage in that period.

In Israel, where the inflation rate has been over 100 percent per annum since 1980 (Table 5), taxation of the business sector dropped to such a level that a new income tax law was enacted in 1983.

7. Effect of Inflation on Price Variability

One of the main side effects of inflation is the increase in uncertainty regarding costs and prices. This phenomenon is presumably caused by the fact that in short periods of time, say, a year, prices of different commodities are not affected uniformly by inflation, although over a longer period of time all prices move more or less in tandem.⁸ To put it differently, the effect of inflation on prices, over short periods of time, is nonneutral.

As long ago as 1927, Frederic Mills in his exhaustive study on wholesale price variations, observed that there is a positive relationship between the relative price change dispersion and the general price level. A more recent study by O. Vining and T. Elwertowski (1976) re-confirmed this positive

relationship in their analysis of wholesale and retail prices in the U.S.A., over the period 1948-1974. The relationship they found was statistically weak, the correlation being relatively low ($r = 0.30$ and 0.22 , our calculation on data from Tables 1 and 2 of their paper, respectively). In this period, the maximum inflation rate was 10 percent per annum.

The purpose of our research is to analyze the effect of high inflation in Israel on price variability, measured in real terms. The analysis was carried out on data of agricultural input prices (supply effects) and consumers in general (demand effects). Data over the period 1968-1981 of 33 agriculture inputs categories (excluding fuel) and 33 aggregate commodities of the Consumer Price Index, were analyzed by regressions. During that period, the annual inflation rate rose continuously from about 2 percent in 1968 to about 130 percent in 1980 and 1981. The results are as follows:

Agricultural supply inputs:

$$S_{a,t} = 0.0598 + 0.1231p_{a,t} \quad (13)$$

(5.710) (5.005)

$$r = 0.822$$

$$DW = 1.083$$

Figures in parenthesis indicate the Students' t value.

All consumer goods:

$$S_{c,t} = 0.0383 + 0.1784p_{c,t} \quad (14)$$

(2.956) (5.518)

$$r = 0.847$$

$$DW = 1.430$$

where $S^2_t = \text{variance}(\log p_{i,t})$

= relative price variability, in real terms for period t ,

$$p_{i,t} = \frac{I_{i,t}/I_{i,t-1}}{I_t / I_{t-1}}$$

$I_{i,t}$ = price index of input or commodity i in year t ,

I_t = aggregate agricultural inputs or Consumer Price Index
in year t ,

$$p_t = \log (I_t/I_{t-1})$$

The results of the analysis of the Israel data provide the following implications:

- 1) Both the supply of producers and the consumer demand are affected by the uncertainty caused by inflation.
- 2) The relationship of price variability is strong in high inflation (correlation of about 0.8 in the case of high inflation as in Israel, compared to correlation of about 0.3 in the case of low inflation as in the U.S.A.).
- 3) The marginal effect of inflation on price variability is lower in the case of administered prices (^{0.123}0.134 in the agricultural inputs) than in non-administered prices (0.178 in consumer prices).
- 4) In the case of agricultural inputs, prices are greatly affected by administrative means, mainly by national policies. The results of this intervention is expressed in the regression by high positive serial correlation (DW = 1.083). On the other hand, in the case of consumer commodities, intervention of government is relatively low, a fact that is expressed by a low serial correlation (DW = 1.430).
- 5) The strong effect of inflation on price variability ($r = 0.8$) may have impacts on increasing uncertainty in supply, which in turn may have indirect effect on reducing supply and enhancing the inflation process in Israel.

Implications for Policy

The following policy implications can be drawn from the impact of inflation on the financial activities of business, under the existing tax rules and financing practices:

Income performance. The model for income measurement as developed in Part IV differs considerably from the USDA-ERS model (and also from the FASB), especially as regards the estimation of operating income (which is under the firm's control) and capital gains, although the total income arrived at by these models is similar. Generally, published data regarding these two income components should be approached with caution. The main difference lies in the allocation of interest expense in calculating operating income and capital gains.

Pricing and costing. The simple rule to follow in costing and pricing is to charge inflation-free interest on the replacement value of fixed assets alongside current-cost depreciation, and to charge nominal interest rates on other assets (inventories and monetary assets) alongside other recorded (unadjusted) input costs.

The practice of charging nominal interest and current cost depreciation on all assets double counts the inflation factor in costing, the consequence of which is an undue rise in prices which in turn enhances the inflation process.

Interest on working capital. The importance of correctly estimating the firm's interest on working capital in costing and in income measurement has been illustrated in Parts II and IV. For the U.S. farm sector in general, the interest on working capital can be estimated as the product of two terms: the market interest rate and three quarters of the current assets. This rule of

thumb may be useful for policy makers in assessing farm cost budgets and farm operating income.

Funds for current assets. The value of current assets, which finance working capital, increases proportionately with inflation. Hence, when these assets are financed by loans, there is a problem for the firm to raise additional funds in order to maintain their purchasing power value. The problem of financing current assets is especially serious when the firm is growing, and when inflation is high and persistent.

Funds for investment. Proper financing of investments requires matching the terms of finance to those of the investment. In other words, investment in fixed assets should be financed by equity and/or by long-term loans. In *Section 4* ~~Chapter 5~~, we illustrated that in time of inflation, the liquidity position of the firm deteriorates through the substitution of long-term loans by short-term loans. The remedy to this problem is to introduce the practice of loan indexation for long-term investments (~~Chapter 6~~).

Financial liquidity. Under the existing income tax rules, firms are induced to substitute equity by loans in order to eliminate and avoid equity erosion. This induces firms to increase the financial leverage. Furthermore, under the existing financing practices (no loan indexation), long-term loans are automatically converted to short-term loans, causing financial stress. This scenario actually occurred in the U.S. farm sector in the last decade: the level of loans per one dollar of gross receipts increased from 90 percent in 1970 to 128 percent in 1982; the ratio of nonreal estate loans to real estate loans increased from 87 percent in 1970 to 101 percent in 1982; and the cash income to one dollar receipts declined from 33 percent in 1970 to 19 percent in 1982.

The remedy to this problem is reconstruction of loans; that is, short-term loans financing fixed assets should be converted to long-term indexed

loans.

Effect of inflation on taxation. The general view is that under the existing tax rules, inflation causes overtaxation. This is true in the case of equity finance. However, the process of equity erosion induces firms to increase the share of loan financing. In Section 6, we illustrated the fact that beyond a given level of financial leverage, the firm reaps net tax benefit which leads to undertaxation. When the inflationary process is persistent, the end result is undertaxation of the business economy.

The preceding taxation effect and the practice of price-setting firms in double counting the inflation factor may explain the failure of many countries in curbing inflation.

Price variability. An important side effect of inflation is the increase in the relative price variability of inputs and finished goods. The higher the inflation rate, the stronger the relationship. The result of this phenomenon is an increase in the uncertainty of supply and demand, which may enhance the inflation process through its effect on reducing supply.

NOTES

1. A similar analysis on cotton production in Israel and a detailed analysis on the actual effect of inflation on cotton production in a period of 10 years has been carried out by Soloman (1982) in a master's thesis under the supervision of Y. Goldschmidt.
2. The Financial Accounting Standards Board (1979) and the Institute of Chartered Accountants in England and Wales (1980). For inconsistencies see Shashua, Goldschmidt and Hillman (1983) and Goldschmidt and Shashua (1984).
3. If equity is added during the year, its value should be maintained equivalent to the value of the opening equity. Thus, the following variable should be subtracted from Relation (6)

$$\sum_i (1 + p_i) (\text{Equity additions})_i \quad (a)$$

where p_i = price level change between month i , when equity is added, and date t -- the closing date of the balance sheet.

A firm's total income is usually composed of retained earnings and payout dividends. To arrive at a correct income figure, the interim dividend payments should be compounded to the end of the year, using the firm's cost of capital, before adding these sums to the end-of-year figure of retained earnings. Under inflationary conditions, the same procedure should be carried out, using the nominal cost of capital. Thus, the following variable should be added to Relation (6).

$$\sum_i (1 + r_i) \text{Dividend}_i \quad (b)$$

where r_i = nominal cost of capital between month i , when dividend is paid, and date t .

Adjustment on net investment is calculated similarly to Relation (a) and added to Relation (6).

4. For further details see Shashua and Goldschmidt (1982).
5. For a proof see Shashua and Goldschmidt (1984).
6. For further details see Shashua and Goldschmidt (1984).
7. Feldstein and Summers (1978) analyzed, in empirical research, the effect of inflation, taxation and leverage on the market interest rates.
8. In the period 1968-1981, the correlation between agricultural input price index and the Consumer Price Index in Israel was 0.992, although significant lags existed between the annual rates.
9. The analysis was carried out at the beginning of the research project in 1982, hence our data extend to 1981 only.

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Percentages

Figure 1
Ratios of Interest on Working Capital to Revenue
Two Farm Activities in Arizona

Figure 2
Ratios of Costs to Revenue
Two Farm Activities in Arizona

Table 1
Income Components
The U.S. Farm Sector, 1950-1982

Year	USDA-ERS ^a		Proposed Model	
	Residual Income to Equity	Real Capital Gains	Operating Income	Capital Gains
1950	5.60	5.40	5.73	4.75
1951	6.70	4.20	6.82	2.92
1952	5.60	-3.90	5.59	-4.86
1953	3.60	-2.60	3.76	-2.30
1954	3.60	-2.10	3.72	-2.77
1955	2.70	5.70	3.02	5.19
1956	2.90	5.30	3.26	5.48
1957	3.30	4.40	3.48	3.70
1958	5.50	10.50	5.74	9.52
1959	2.90	1.80	3.27	1.44
1960	4.10	0.20	4.50	-0.60
1961	5.00	6.90	5.40	6.19
1962	5.50	5.70	6.00	4.60
1963	5.40	4.70	5.90	3.54
1964	4.40	7.20	5.15	7.25
1965	7.50	11.90	8.24	10.36
1966	8.50	7.30	9.35	6.57
1967	6.30	4.90	7.16	3.35
1968	6.10	3.80	7.03	2.61
1969	7.80	-0.70	8.92	-2.42
1970	7.80	-0.70	9.16	-2.50
1971	8.00	13.20	9.37	10.72
1972	13.20	28.70	14.75	27.00
1973	28.60	44.00	30.57	41.81
1974	19.90	2.10	22.39	0.13
1975	17.90	37.90	20.51	33.72
1976	11.90	59.30	15.16	59.91
1977	10.50	27.60	14.32	23.84
1978	18.00	64.90	22.85	63.74
1979	22.10	23.50	28.23	13.78
1980	10.40	-4.70	18.06	-10.72
1981	16.50	-75.10	26.57	-101.16
1982	9.60	-60.90	20.53	-79.88

^aSource: USDA (1983), pp. 125, 126.

Table 2

Cash Flow from \$1,000 Investment Financed by Installment Loan
Case of Zero Profit

Year, end	0	1	2	3	4
Price index	100.00	120.00	144.00	172.80	207.36
<u>A. Cash Flow</u>					
Investment	\$(1,000)	\$322.84	\$387.40	\$464.88	\$557.86
Loan ^a	<u>1,000</u>	<u>(412.93)</u>	<u>(412.93)</u>	<u>(412.93)</u>	<u>(412.93)</u>
Net cash flow	-	(90.09)	(25.53)	51.95	144.93
<u>B. Needs for Short-Term Loans^b</u>					
		$(90.09) \times 1.236 = \frac{(111.35)}{(136.88) \times 1.236 = \frac{(169.18)}{(117.23) \times 1.236 = \frac{(144.90)}{-}}$			
Cumulative needs		90.09	136.88	117.23	-
<u>C. Balance of Liabilities</u>					
Short-term loans		\$ 90.09	\$136.88	\$117.23	\$ -
Long-term loan ^c		<u>823.07</u>	<u>604.38</u>	<u>334.09</u>	<u>-</u>
Total		913.16	741.26	447.32	-
Percentage of short loans	10%		18%	26%	-

^aAmortization factor based on 23.6 percent interest.

^bThe short-term loans bear 23.6 percent interest.

^cOpening balance less principal repayment which is equal to total payment less 23.6% on the opening balance.

Table 3

Financial Statements and Income Tax Liability under Inflation
Investment of \$1,000

Year, end	0	1	2
Price index	100.000	120.000	144.000
<u>Cash Statements</u>			
EBIDT		\$600	\$720
Interest, 20%		(200)	(120)
Surplus		400	600
Loan repayment		(400)	(600)
Retained cash		-	-
<u>Balance Sheets</u>			
Assets, historical	\$1,000	\$500	\$ -
current	1,000	600	-
Loan	1,000	600	-
<u>Income Tax Liabilities: Actual vs. Correct</u>			
(1) Depreciation, current		\$600	\$720
historical		(500)	(500)
Difference		100	220
Present value, 20%	\$236.11		
(2) Interest, real, 0%		\$ -	\$ -
actual, 20%		(200)	(120)
Difference		(200)	(120)
Present value	(250.00)		
(3) Net tax liability, (1)-(2)		(100)	100
Present value, 20%	(13.89)		

EBIDT = earnings before interest, depreciation and tax.

Table 4
Tax Liabilities Resulting from Inflation-Tax Effects
The U.S. Farm Sector, 1960-1974
Billion Dollars, Nominal Prices

Year	Depreciation ^a			Interest			Net Tax Liability ^c
	Historical	Current	Difference	Actual ^b	Imputed	Difference	
1960	3.12	4.34	(1.22)	1.27	0.90	0.37	(0.85)
1961	3.14	4.39	(1.25)	1.32	0.90	0.42	(0.83)
1962	3.24	4.53	(1.29)	1.48	1.00	0.48	(0.81)
1963	3.34	4.70	(1.36)	1.65	1.10	0.55	(0.81)
1964	3.45	4.90	(1.46)	1.80	1.15	0.65	(0.81)
1965	3.58	5.11	(1.53)	1.99	1.26	0.73	(0.80)
1966	3.76	5.38	(1.63)	2.21	1.35	0.86	(0.77)
1967	4.02	5.78	(1.76)	2.46	1.54	0.92	(0.84)
1968	4.29	6.20	(1.91)	2.64	1.67	0.97	(0.94)
1969	4.51	6.57	(2.06)	2.90	1.78	1.12	(0.94)
1970	4.78	6.76	(1.98)	3.20	1.95	1.25	(0.73)
1971	5.24	7.35	(2.11)	3.38	2.15	1.35	(0.76)
1972	5.48	7.89	(2.40)	3.67	2.03	1.52	(0.88)
1973	6.08	8.94	(2.86)	4.43	2.43	2.00	(0.86)
1974	6.84	10.64	(3.80)	5.43	2.92	2.51	(1.29)

^aSource: USDA, 1976, p. 23.

^bSource: USDA, 1983, p. 15.

^cDifference between depreciation charges and interest charges.

Table 5
Inflation and Price Variability
Israel, 1961-1981

Year	Agricultural Inputs		Consumer Goods	
	Price Level Change	Standard Deviation	Price Level Change	Standard Deviation
1968	7.88%	6.254%	2.17%	3.97%
1969	7.88	3.145	2.43	2.31
1970	6.91	4.018	6.06	3.33
1971	12.35	7.133	12.01	3.95
1972	13.39	7.655	12.82	4.92
1973	17.91	10.036	19.99	7.21
1974	55.14	14.149	39.74	11.74
1975	46.53	12.663	39.27	15.19
1976	33.41	10.835	31.34	12.62
1977	41.80	13.068	34.61	11.04
1978	51.41	13.363	50.59	10.46
1979	78.02	8.646	78.30	8.43
1980	146.40	15.878	131.02	21.42
1981	118.40	14.784	116.80	14.69

Description and Results of Cooperation

A final draft of the research program between the two cooperators was prepared together in a meeting in Athens, Greece in October, 1980. Work officially began in 1981 and terminated in 1983 with a six-month extension to March 31, 1984.

During the first year, there was constant communication by correspondence and telephone, and in the initial part of the project, an Israeli research associate was employed in Arizona for several months in late 1981 to assist in gathering data on United States agriculture relating to the project.

The Principal Investigator, Dr. Hillman, came to Israel for approximately two weeks in September 1982 (September 10-22) to study the results of the first part of the research and to make suggestions on procedures and methodology. In addition, Dr. Hillman assisted in planning the second year's program of action which involved more indirect as well as direct interaction between project personnel.

The cooperators, from the beginning, made sure that the computerized model which was developed for financial analyses of farms was written in English so as to enable its actual use in the United States as well as in Israel.

In Israel, a Master's degree thesis was finished which related to the project at hand and there was some additional utilization of the research.

For example, Dr. Hillman when he was testifying before a subcommittee of the Committee on Finance, United States Senate in 1984, utilized the results of this research to demonstrate the impact of inflation on United States agricultural assets and incomes.

The personnel in Israel spent time in the United States in 1983-84 working on the project. Dr. Yaaqov Goldschmidt came to the University of Arizona to finalize the project and to assist in drafting manuscripts which resulted from the research. Dr. Leon Shashua spent time in the Spring of 1984 working specifically on the model and various manuscripts.

Several outstanding results came about from the cooperation between the two countries and the personnel. First, there was the research itself and the report which has resulted therefrom. Second, there is a suggested correction in the methodology which is being used by the Economic Research Service, United States Department of Agriculture, which comes from Israeli experience. Third, the personnel on the project have been invited to write a major paper on the subject matter for the Winter Meeting of the Allied Social Sciences in Dallas, Texas in December, 1984. Specifically, the paper will be published in the Proceedings of the American Economics Association (AEA) and the American Agricultural Economics Association (AAEA). Finally, a book will be published as a collaborative effort between the participants.

In sum, this project has been a very successful cooperative effort and it has been a project which has resulted in closer cooperation between the professionals involved.

Benefits to Agriculture

1. Important aspects of the impact of inflation on financial activities are clarified and quantified for the benefit of firms and policymakers.
2. Models for income measurement under inflation (USDA-ERS; FASB) were analyzed and found to have theoretic inconsistencies and pitfalls. An improved model was developed. In addition, cost budgeting procedures used in agriculture were found to be at fault as regards the imputation of interest expenses. These procedures usually double count the inflation factor.
3. A monograph will be published in which the U.S. farm sector is analyzed for the period 1950-1982. Published U.S. data regarding income components are adjusted to inflation. Time series data adjusted to inflation for performance evaluation, financial liquidity, equity formation, and interest on working capital are provided.
4. The model for income measurement under conditions of inflation developed in this research is currently applied in Israel for analyzing the economic performance of the kibbutzim.

List of Publications

- Shashua, L. and Y. Goldschmidt, "Inflation Consideration in the Cost of Investment," Omega--The International Journal of Management Science, Volume 10, No. 6, 1982, pp. 695-697.
- _____, "Type of Loan and Financial Liquidity under Inflation," The Center for Agricultural Economic Research, Working Paper in Hebrew, Rehovet, 1982.
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