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An empirical study of inflation distortions to EVA

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Abstract

Proponents of economic value added (EVA) argue that changes in the metric accurately measure changes in the performance of a firm or business unit through time and therefore can represent a reliable measure of managerial effectiveness. However, inflation distorts EVA through the operating profit, the cost of capital, and the capital base and these distortions have the potential to result in inefficient investment and compensation outcomes. Using an inflation-corrected EVA metric, I measure the sensitivity of EVA to the level of, and changes in, inflation for a large sample of US stocks and find evidence of significant inflation induced distortions.

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1. Introduction

While there is an extensive literature on the properties economic value added (EVA),¹ little is known about the effects of inflation on this popular performance metric.² The prevailing assumption by EVA practitioners is that inflation has little impact on EVA. Indeed,

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¹ For analysis of EVA see Biddle, Bowen, and Wallace (1997), Dillon and Owers (1997), Machuga, Pfeiffer, and Verma (2002), Stewart (1994), and Walbert (1994).

² Ryan and Trahan (1999) report that 50% of 184 survey respondents use EVA.

Bennett Stewart, in his book on EVA, *“The Quest for Value”*, argues that as long as inflation is less than 10%, managers do not need to make inflation adjustments.³ The argument against inflation adjustments assumes that when EVA is used as a performance metric, it is changes in EVA that should be considered, and the absolute level of EVA, which may be distorted by inflation, is of no concern. Stewart explicitly assumes that when inflation is low, changes in EVA are uncorrelated with changes in inflation. To date, however, no compelling evidence has been presented to support or refute this assumption.

There is a paucity of research on inflation distortions to EVA. The most directly related work in this area is that of De Villiers (1997) who examines inflation distortions to EVA in a modeling framework. His analysis principally focuses on the distortions to EVA caused by inflation’s effect on the firm’s asset base. This paper builds upon the work of De Villiers by including two other major inflation distortions and by examining the distortions on a real sample of firms. My approach adds to our understanding of inflation’s impact on EVA in several ways. First, by examining real data, I am able to capture the diversity of firms in terms of varying capital structures, earnings histories and inflation patterns; second, several of the inflation distortions that I study may have offsetting effects and the degree to which these effects offset each other is an empirical question; third, I examine the relation between changes in EVA and inflation, as it is changes in EVA which form the basis of EVA-based compensation schemes. The impact of inflation on residual income models (which can be thought of as multi-period EVA models) is also examined by Ritter and Warr (2002) who correct the Edwards Bell and Ohlson⁴ residual income model to account for the distortions of inflation. My analysis modifies and applies the inflation adjustments formulated in Ritter and Warr (2002).

The use of nominal accounting values and nominal costs of capital have the potential to affect EVA in important ways. Inflation causes both upwards and downwards distortions to EVA and there is no reason to assume that these are offsetting. The net distortion of EVA depends upon the interaction of several firm characteristics and past and present levels of inflation. I examine the distortions that inflation causes to EVA in a theoretical framework and then present adjustments that could be used in practice to estimate EVA in the presence of inflation. After making the necessary adjustments, I then estimate EVA for a large sample of US companies using both the “nominal” approach and the “real” approach introduced in this paper.

I find that in the past 28 years (1975–2002), inflation has significantly distorted traditional or nominal EVA however, during this time period, inflation (as measured by the annual change in the GDP deflator) ranged from 1.13 to 9.7%. I therefore analyze the second half of my sample from 1990 onwards during which inflation ranged from 1.13 to 4.15% and find very similar results to the full sample, indicating that even in the low inflation environment of the 1990s the impact of inflation on EVA remains significant.

For firms that rely on EVA as a measure of operating performance, failure to correct EVA for the distorting effects of inflation will result in the misallocation of capital and inconsistent managerial compensation and therefore an understanding of the impact of inflation on EVA is essential.

³ See p. 227 of Stewart (1991).

⁴ See Feltham and Ohlson (1995).

2. Nominal and real EVA

The focus of my analysis is a comparison of nominal EVA (which is my estimation of EVA proposed by Stewart, 1991) and real EVA (which is the inflation corrected measure developed in this paper). I start with nominal EVA and then correct this metric for various inflation distortions. Unlike much of the existing literature, which uses EVA numbers provided by Stern Stewart, I attempt to compute EVA directly. This presents a unique challenge because some of the adjustments to earnings and capital employed by Stern Stewart are proprietary. Therefore, I will focus on the adjustments discussed by Stewart (1991). By ignoring the “black box” adjustments I am assuming that these adjustments are inflation neutral (which seems reasonable by the implicit admission of Stewart) and that the same adjustment would apply to both the nominal and real EVA metrics and thus ignoring such adjustments should not affect the conclusions on the impact of inflation. My estimation of EVA uses Compustat data as the primary source and I draw on Yook (1999) who provides a road map for estimating EVA using Compustat. First, however, I will discuss the specific inflation distortions to EVA.

Expanding the basic formula for EVA:

$$\begin{aligned} \text{EVA}_t &= \text{NOPAT}_t - \text{wacc} \times \text{capital}_{t-1} = \text{NOPAT}_t - \text{wacc} \times [B_{t-1} + D_{t-1}] \\ &= \text{NOPAT}_t - \left[R_e \times \frac{B_{t-1}}{B_{t-1} + D_{t-1}} + R_d(1-t) \times \frac{D_{t-1}}{B_{t-1} + D_{t-1}} \right] \\ &\quad \times [B_{t-1} + D_{t-1}] = \text{NOPAT}_t - R_e B_{t-1} - R_d(1-t)D_{t-1} \end{aligned} \quad (1)$$

where NOPAT is the net operating profit less adjusted taxes, wacc the weighted average cost of capital, B_t the equity capital, D_t the debt capital (assuming that the Stern Stewart adjustments to capital are made to the equity and debt components), R_e the nominal required return on equity, R_d is the nominal required return on debt. Inflation distorts this definition of EVA in three ways: through NOPAT, through wacc and through capital. It is very important to realize that these distortions are not due to inflation surprises—they occur in the presence of fully anticipated inflation.

2.1. NOPAT: the effect of historic depreciation expense

The first distortion is on the level of NOPAT. A key assumption of EVA is that accounting depreciation is equal to economic depletion of assets. This cost is captured within NOPAT, but a significant wedge between accounting and economic depreciation can occur following a period of protracted inflation, resulting in the replacement cost of the asset far exceeding the historic purchase price. Therefore, the difference between accounting depreciation and replacement cost depreciation should be subtracted from NOPAT.

2.2. NOPAT: the inflation-induced decline in the value of nominal debt

Proponents of the nominal EVA formulation: $\text{EVA} = \text{NOPAT} - \text{wacc} \times \text{capital}$, claim that the metric measures economic gains to equity, but for levered firms in the presence of inflation it ignores an important source of economic gain. Specifically, it does not capture

the real depreciation of nominal debt that occurs in the presence of inflation, but it does include the nominal cost of debt (through the wacc). This distortion was originally presented in Modigliani and Cohn (1979) and is examined in Cohn and Lessard (1981), Cagan (1982), Ritter and Warr (2002), Sharpe (2002) and Ritter (2003). It is the least intuitive and less well known of the inflation distortions to accounting values.

In the presence of fully anticipated and steady inflation, the value of the firm's dollar denominated debt declines in real terms, while the real value of the firm's assets (that were financed with the debt) remain level, assuming that the firm invests in real assets. The net result for the borrower is that in real terms her leverage ratio declines. Lenders are compensated for this decline in the value of their asset (the debt) by higher nominal interest rates that incorporate an inflation premium. These higher interest costs result in a higher wacc and hence lower EVA for a levered firm in the presence of inflation. What the nominal definition of EVA ignores is the fact that the value of the debt owed by the firm is being eroded by inflation. In essence, inflation serves to pay off a portion of the debt each year by eroding the value of the fixed dollar contract. This erosion results in a capital gain to equityholders, which offsets the higher nominal interest costs that the firm must pay. Therefore, in the presence of inflation the EVA of levered firms will understate true economic earnings.

A simple example can illustrate this point. Consider a firm with US\$ 100 of assets all financed by debt. The firm has a basic earning power of 10%, and therefore its operating income is US\$ 10. The real cost of debt for the firm is 2%, and inflation is 0%. The firm is in a 40% tax bracket. The firm experiences no real growth in sales. The firm's NOPAT is thus $100 \times 0.1 \times (1 - 0.4) = \text{US\$ } 6$. The EVA for the firm is therefore: $6 - 0.02 \times (1 - 0.4) \times 100 = \text{US\$ } 4.8$. Now assume an identical situation where inflation is now 5% during the year. The firm's marginal cost of debt increases to $2\% + 5\% = 7\%$. At the same time the firm's real assets will increase in value at the rate of inflation to US\$ 105, and as the basic earning power is fixed, the firm's operating income will be US\$ 10.50. The new EVA will be: $10.5 \times (1 - 0.4) - 0.07 \times (1 - 0.4) \times 100 = \text{US\$ } 2.1$. The firm appears to have suffered a significant decline in its EVA from US\$ 4.8 to 2.1. At first glance this makes sense as the firm's interest costs increased by 5% due to inflation, but this ignores what has happened on the balance sheet. The firm's real assets have increased to US\$ 105 due to inflation, but the firm's debt remains at US\$ 100 therefore, the firm has gained US\$ 5 in equity (the actual magnitude of the gain is equal to the inflation rate multiplied by the value of the debt). To restore the original level of leverage the firm can now issue US\$ 5 of new debt and supplement EVA with the proceeds. Thus, the real economic gain to the firm is $\text{US\$ } 2.1 + \text{US\$ } 5 = \text{US\$ } 7.1$. This gain is more than the non-inflation net income of US\$ 4.8, because the US\$ 5 gain is not taxed whereas the nominal interest expense is tax deductible.

This intuition is analogous to a homeowner who, in a period of high inflation, has a mortgage with a high nominal borrowing cost (and therefore less disposable income). Due to the nominal appreciation of the house, however, the homeowner is able to take out a home equity loan and supplement his or her disposable income with the proceeds. Indeed, to keep the loan to value ratio constant, the homeowner must constantly borrow more. Furthermore, the equity gain to the homeowner is not taxed, whereas the inflation component of the interest expense is tax deductible (see Ritter and Warr, 2002, p. 32).

This distortion is entirely independent of inflation shocks and will occur during periods of steady state inflation. Furthermore it is not dependent on the firm having floating rate debt. Modigliani and Cohn (1979) and Ritter and Warr (2002) show the correction to net income to be fairly simple. The depreciation of nominal debt is $p \times$ net debt each year, where p is the inflation rate for the year and net debt is the nominal debt of the firm less nominal assets.

2.3. Capital: historic cost-based book values

Inflation, through its effect on depreciation, also leads to book equity being understated relative to replacement cost. As book equity represents part of the capital base on which the required return is computed, this leads to an overstatement of EVA following a period of inflation. Replacement book equity is estimated by adjusting historical capital expenditures over the life of the firm's assets for the effect of past inflation.

2.4. WACC: real versus nominal required returns for calculating EVA

Because EVA uses nominal required returns, it underestimates value created in the presence of inflation. Using the previously expanded definition of EVA:

$$EVA_t = NOPAT_t - R_e B_{t-1} - R_d(1-t)D_{t-1} \quad (2)$$

If we ignore the cross product from the Fisher equation for simplicity, we can represent $NOPAT_t$ as $NOPAT_{t-1}(1+p+g)$, where p is the inflation and g is the real growth. Further if we recognize that the nominal return is equal to the real return plus inflation (again ignoring the cross product), we can express EVA as:

$$EVA_t = NOPAT_{t-1}(1+p+g) - (r_e + p)B_{t-1} - (r_d + p)(1-t)D_{t-1} \quad (3)$$

where r_e is the real cost of equity, and r_d is the real cost of debt.

Taking the first derivative to examine the effect of inflation, p , on EVA, we get,

$$\frac{\partial EVA}{\partial p} = NOPAT_{t-1} - B_{t-1} - (1-t)D_{t-1} \quad (4)$$

This derivative is negative, as long as the capital exceeds NOPAT, which is likely in for most firms. Therefore, the use of nominal rates in EVA will result in a decline in EVA when inflation increases.

2.5. The corrected EVA metric

The inflation corrected EVA metric (real EVA) incorporates the depreciation adjustment, the debt adjustment, a real cost of capital and the replacement book values:

$$\text{real EVA}_t = \frac{NOPAT_t}{1+p} + pD_{t-1} - DA_t - wacc_{\text{real}} \times \text{replacement capital}_{t-1} \quad (5)$$

where p is the inflation rate, pD the gain from the depreciation of debt, DA the depreciation adjustment to correct for historically based depreciation expense, and replacement capital is the capital base adjusted for replacement costs.

The inflation corrected measure of EVA has some common elements to the CFROI performance metric (Madden, 1999). CFROI incorporates real rates of return and also attempts to correct for inflation's distorting effect on the asset base in a manner similar to the one used in this paper and the work of De Villiers (1997). CFROI does not, however, correct for the depreciation of nominal debt, which represents a significant distortion to both EVA and CFROI.

The difference between nominal EVA and real EVA will depend upon the characteristics of the individual firm, and the degree to which these characteristics are influenced by the inflation rate. The debt adjustment, and use of real cost of capital will serve to boost real EVA relative to nominal EVA, but these effects may be offset by the depreciation adjustment and the use of the replacement book value of equity which will serve to lower real EVA relative to nominal EVA.

The importance of incorporating inflation in the EVA computation is an empirical question. The following section will discuss practical computation of the adjustments and empirically examines the distortions that inflation causes to EVA.

3. Empirical estimation of nominal EVA and real EVA

The sample comprises all US publicly traded stocks from 1974 to 2002 for which data are available on Compustat and CRSP. I use only firms with December year-ends for simplicity and compute real and nominal EVA for each firm on an annual basis. Firm accounting data primarily come from Compustat. CRSP data were used for the computation of the equity cost of capital. To estimate capital and NOPAT I rely on Yook (1999) who presents the following formulation using Compustat data⁵:

$$\begin{aligned}
 \text{capital} = & \text{total assets : [Data item 6]}_{t-1} \\
 & - \text{non-interest bearing current liabilities : [Data item 5]}_{t-1} \\
 & - [\text{Data item 34}]_{t-1} - \text{marketable securities : [Data item 193]}_{t-1} \\
 & - \text{construction in progress : [Data item 266]}_{t-1} \\
 & + \text{present value of non - capitalized : [Data item 96]}_{t-1}/1.1 + [\text{Data item 164}]_{t-1}/ \\
 & (1.1^2) + [\text{Data item 165}]_{t-1}/(1.1^3) + [\text{Data item 166}]_{t-1}/(1.1^4) \\
 & + [\text{Data item 167}]_{t-1}/(1.1^5) \\
 & + \text{bad debt reserve : [Data item 343]} \\
 & + \text{LIFO reserve : [Data item 240]} \\
 & + \text{R\&D expense depreciated and capitalized : [Data item 46]}_{t-3} \times 0.2 + \\
 & [\text{Data item 46}]_{t-2} \times 0.4 + [\text{Data item 46}]_{t-1} \times 0.6 + [\text{Data item 46}]_t \times 0.8 \\
 & + \text{cumulative unusual losses (gains) after taxes : } S[\text{Data item 48}]_{t-30,t}
 \end{aligned} \tag{6}$$

⁵ I (and Yook, 1999) am unable to include amortization of goodwill in our computations as this item is not available on Compustat.

$$\begin{aligned}
\text{NOPAT} &= \text{net operating profits [Data item 178]}_t \\
&+ \text{increase in bad debt reserve [Data item 343]}_t - [\text{Data item 343}]_{t-1} \\
&+ \text{increase in LIFO reserve [Data item 240]}_t - [\text{Data item 240}]_{t-1} \\
&+ \text{increase in net capitalized R\&D expense (change in the capital variable)} \\
&+ \text{other operating income [Data item 190]} \\
&- \text{cash operating taxes [Data item 317]}
\end{aligned} \tag{7}$$

To estimate the weighted average cost of capital I separately estimate the cost of equity and the cost of debt. Yook (1999) estimates a simple market model to arrive at the cost of equity capital, but I choose to use the method Fama and French (1997) who estimate costs of capital for 48 industry classifications using a three factor model.⁶ The advantage of this approach over the firm-specific single-index model is that the industry costs of capital tend to be much less volatile than individual firm costs of capital. In this paper I seek to reduce noise in the time series of my EVA estimation so that I can focus on the substantive reasons for changes in EVA. The Fama and French (1997) method uses monthly returns as follows:

$$r_{\text{ind}} - r_{\text{rf}} = \alpha + \beta_1(r_{\text{m}} - r_{\text{rf}}) + \beta_2 \text{SMB} + \beta_3 \text{HML} + \varepsilon \tag{8}$$

where r_{ind} is the return on the industry portfolio, r_{rf} the risk free rate, r_{m} the return on market, SMB the “small minus big” portfolio return, and HML is the “high minus low book to market” portfolio return.⁷ Equation (8) is estimated for a rolling window of 30 years of monthly observations for each of the 48 industry groups. The nominal cost of equity capital is then predicted from the estimated equation using the mean levels of the market, HML and SMB returns.

I modify the method of Yook (1999) for estimating the cost of debt capital. For those firms for which Compustat reports a debt rating, I use the yield on newly issued debt as reported by Moody’s Stock and Bond Manual for that year and rating. For the firms that do not have a debt rating, I estimate a synthetic rating using the method of Damodaran (2002). First I compute the times interest earned ratio for each firm that does not have a rating, I then use the table of interest coverage ratios and ratings in Appendix A to create a synthetic bond rating for the firm. The firm is then matched up with the appropriate yield on newly issued debt for firms with that rating. The newly issued yield data only exist for ratings of BBB and above. For lower ratings I apply a default spread over the BBB bond yield for that year based on the magnitude of the times interest earned ratio. The default spreads used are presented in Appendix A.

The nominal weighted average cost of capital is estimated as:

$$\text{wacc} = R_e \frac{B_{t-1}}{B_{t-1} + D_{t-1}} + R_d(1 - t) \frac{D_{t-1}}{B_{t-1} + D_{t-1}} \tag{9}$$

⁶ EVA computed using the three factor risk premiums are reported in the paper, but the results are not materially different when just the market factor is used. I also use a beta of unity for all stocks and get similar results (as employed by Lee, Myers, & Swaminathan, 1999).

⁷ These data are available from Ken French’s website: <http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/>.

where R_e is the nominal cost of equity (i.e. $R_e = (1 + r_{ind})(1 + r_f) - 1$), R_d the nominal cost of debt, B the book value of equity and D is the book value of debt. By using book values, I implicitly assume that the firm's debt is trading at par.⁸

The real weighted average cost of capital is computed as:

$$wacc_{real} = \frac{1 + wacc_{nom}}{1 + p} \quad (10)$$

where $wacc_{nom}$ is the nominal weighted average cost of capital and p is the inflation rate measured by the change in the GDP deflator.

I modify Ritter and Warr's method for estimating a depreciation adjustment. This requires several simplifying assumptions: (a) asset depreciable life is equal to asset economic life; (b) replacement of assets happens steadily through time; (c) inflation has been steady over the life of the assets.

The depreciation adjustment, DA_t , is computed by estimating the average age of the assets and then using this to gross up the depreciation expense by the amount of inflation that occurred over the life of the assets, i.e.

$$DA = \text{depreciation expense}_t \times \left[\frac{GDP_t}{GDP_{t-age}} - 1 \right] \quad (11)$$

where

$$\text{age} = \frac{\text{accumulated depreciation}}{\text{depreciation expense}}$$

Age represents an estimate of the average age the assets, depreciation expense is the annual depreciation and amortization expense reported in Compustat item 14, and GDP_t is the level of the GDP deflator at time t .

RB, replacement book equity, is book equity adjusted for the effects of inflation on historical cost depreciation. To compute replacement book I first estimate the life of the assets, in order to enable the creation of a simulated depreciation schedule. The estimate of the asset life, n , is:

$$n = \frac{\text{gross property plant and equipment}}{\text{depreciation expense}} \quad (12)$$

The first step in computing RB is to estimate the capital expenditures, X , that the firm would make each year to replenish depreciated assets and to grow the asset base at a nominal rate G . The book value of assets at time t will equal the sum of the previous capital expenditures that remain not fully depleted:

$$B_t = \sum_{i=1}^n \frac{i}{n} X_{t-(n-i)} \quad (13)$$

⁸ Ritter and Warr (2002) find that their results are not significantly impacted when they make this assumption, compared to when they actually estimate the true market value of the debt.

For example, the book value of a firm with a 3 year asset life is equal to $X_t + 2/3X_{t-1} + 1/3X_{t-2}$. All of the capital expenditures from more than 3 years ago have been fully depreciated and are thus no longer present in the t book value. Given nominal growth rate of assets of G , we can express all capital expenditures in terms of the current capital expenditure X_t , as $X_{t-(n-i)} = X_t/(1+G)^{(n-i)}$ by discounting by $1+G$ per year.

Thus, the value of the assets at time t is:

$$B_t = \sum_{i=1}^n \frac{i}{n} \frac{X_t}{(1+G)^{(n-i)}} \quad (14)$$

rearranging yields:

$$X_t = \frac{B_t}{\sum_{i=1}^n \frac{i/n}{(1+G)^{n-i}}} \quad (15)$$

Replacement book is therefore the same as book (Equation (14)), except that I gross up the capital expenditures by the inflation rate each period, this:

$$RB_t = \sum_{i=1}^n \frac{(i/n)X_t(1+\pi)^{n-i}}{(1+G)^{n-i}} \quad (16)$$

where π , the amount of inflation, is estimated as $(GDP_t/GDP_{t-n})^{1/n} - 1$ and the growth rate, G , is $ROE \times (1 - dpr)$, and dpr is the dividend payout ratio. For firms with negative ROE, G is set to equal zero, as we assume that firms would not grow their asset base by investing projects with negative return.⁹ To convert the nominal capital measure to replacement capital I take capital (Equation (6)), deduct book equity, and add replacement book equity (Equation (16)).

The debt adjustment requires a measure of the nominal debt of the firm. Consistent with French, Ruback, and Schwert (1983) and Ritter and Warr (2002) I use the net debt position (NETDEBT) of the firm. I compute NETDEBT as the sum of nominal liabilities less the sum of nominal assets.¹⁰

4. Results and analysis

4.1. Univariate analysis

Table 1 presents the summary statistics of the various components that make up both real and nominal EVA. During the sample period, inflation averaged around 3.5%. The

⁹ I recode the ROE of negative ROE firms to zero only for the purpose of estimating the growth rate. I do not impose any restrictions on ROE in the rest of the analysis.

¹⁰ The Compustat items are: debt in current liabilities (34) (current portion of debt and debt under 1 year), accounts payable (70), income taxes payable (71), current liabilities-other (72), long-term debt-total (9), liabilities-other (75), deferred taxes (35), minority interest (38), preferred stock (130), minus nominal assets of cash and short term investments (1), receivables-total (2), current assets-other (68), investments and advances-other (32). Nominal assets such as credit card receivables are generally classified under Compustat item 32. We also use just long-term debt (9) in place of NETDEBT, and find no significant changes in the results.

Table 1
Summary statistics

Variable	Observed	Mean	Median	S.D.	Minimum	Maximum
NOPAT	47979	174.59	17.34	719.59	-5267.32	29728.80
Capital	47979	2024.44	194.00	11891.85	-567.00	648879.30
Replacement capital	47979	2179.75	212.06	12116.77	-554.93	651391.90
Nominal wacc	47979	8.36%	8.03%	2.34%	3.05%	19.20%
Real wacc	47979	5.33%	5.18%	1.49%	1.22%	11.02%
Depreciation adjustment (DA)	47979	22.05	1.41	83.35	<0.001	2655.04
Debt adjustment (pD)	47979	21.27	0.88	77.05	-291.91	3069.18
Nominal EVA	47979	48.91	2.99	512.47	-32834.47	18397.66
Real EVA	47979	75.97	5.33	502.00	-26331.67	20601.29
Inflation	27	3.50%	2.43%	2.28%	1.13%	9.70%

All dollar amounts are expressed in millions. NOPAT is net operating profit less adjusted taxes, capital is the capital base used in the EVA computation. Replacement capital is the adjusted capital base for the effects of historic cost accounting. Nominal wacc is the weighted average cost of capital using a nominal cost of equity estimated using the Fama and French (1997) method and a cost of debt using prevailing bond rates or a synthetic bond rating. The depreciation adjustment is the dollar difference between actual depreciation expense and depreciation expense based upon the inflation adjusted replacement book value of assets. The Debt adjustment is the nominal liabilities less nominal assets (D) all multiplied by the most recent annual inflation rate (p). This adjustment measures the real depreciation of the firm's liabilities that occurs in the presence of inflation. Nominal EVA is computed without any inflation adjustments while real EVA is nominal EVA corrected for the effects of inflation (see the text for a full discussion). Inflation is measured as the annual change in the GDP implicit price deflator.

average nominal cost of capital is about 8.4%, while the average real cost of capital is 5.3%. The average debt adjustment is US\$ 21 million, while the depreciation adjustment is US\$ 22 million. As discussed above, even though these adjustments are similar in size and opposite in sign, the degree to which they actually offset each other will depend on firm characteristics and past and present inflation. The time series of the average debt and depreciation adjustments are presented in Fig. 1. The net adjustment (the sum of the two adjustments) shows significant fluctuations through time.

Inflation increases replacement book capital relative to reported book capital by 7.7%. Higher replacement capital will offset the lower real wacc to some degree, but the combined effect cannot be deduced in a univariate framework. Average nominal EVA is US\$ 48.91 million while average real EVA is US\$ 75.97 million. This difference indicates that that on an aggregate level at least, inflation has the effect of distorting EVA lower rather than higher.

In Table 2, I examine whether any of the differences between the real and nominal variables are significant. Panel A uses two-tailed t -tests and finds that real EVA is significantly greater than nominal EVA. In Panel B, I re-run the tests using non-parametric tests to reduce the impact of outliers. Again the median real EVA is significantly greater than the median nominal EVA.

Correlations between major determinants of EVA are presented in Panel A of Table 3. Not surprisingly, the correlation between real and nominal EVA is very high (0.9398). The depreciation and debt adjustments are positively correlated (0.6791), but these adjustments are far from perfectly correlated, and this will reduce the degree to which they offset each other.

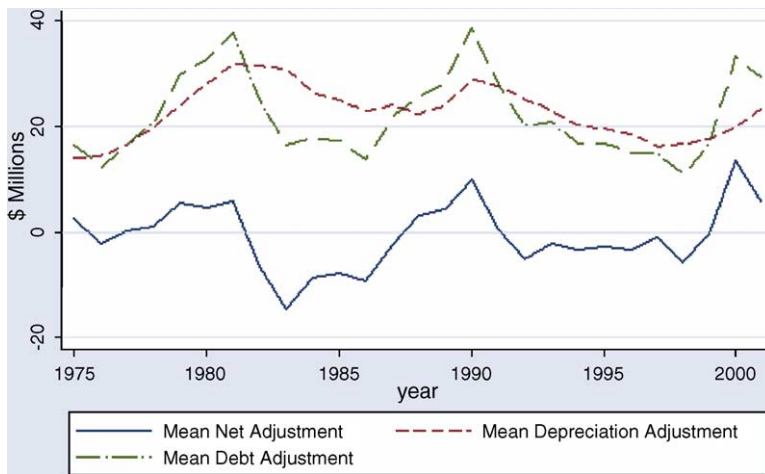


Fig. 1. Debt, depreciation and net adjustments to NOPAT.

4.2. Multivariate analysis

Before I present the full regression analysis I examine the correlations between the variables that will be used in the regression models. These correlations are presented in Panel B of Table 3. I compute a new variable that measures the difference between real and nominal EVA. The difference is computed as:

$$\text{EVADIFF} = \frac{\text{real EVA}}{\text{replacement capital}} - \frac{\text{nominal EVA}}{\text{capital}} \quad (17)$$

In essence EVADIFF is measuring the difference in the amount by which the real return on investment exceeds the real cost of capital versus the difference by which the accounting return on investment (NOPAT/capital) exceeds the nominal cost of capital. This can be seen

Table 2
Univariate tests of real and nominal EVA and their components

Panel A, two-tailed <i>t</i> -tests	Difference
Real EVA less nominal EVA	27.06 (<0.001)
Depreciation adjustment less debt adjustment	0.77 (<0.001)
Replacement book less book equity	154.81 (<0.001)
Panel B, sign rank tests	Percent positive
Real EVA less nominal EVA	76.70 (<0.001)
Depreciation adjustment less debt adjustment	62.90 (<0.001)
Replacement book less book equity	>99.99 (<0.001)

Panel A presents simple two-tailed *t*-tests of the null hypothesis that the differences between key variables is equal to zero. *P*-Values of *t*-tests are shown in parenthesis. Panel B presents Wilcoxon sign rank tests between key variables, which tests the null that 50% of the observed differences are positive. *P*-Values of *Z*-tests are shown in parenthesis.

Table 3
Correlations between major variables

	Nominal EVA	Real EVA	Debt adjustment	Depreciation adjustment	Capital	Replacement capital	
Panel A, correlations between components of nominal and real EVA							
Real EVA	0.9398 (0.0000)						
Debt adjustment	0.2461 (0.0000)	0.4879 (0.0000)					
Depreciation adjustment	0.3902 (0.0000)	0.4650 (0.0000)	0.6971 (0.0000)				
Capital	0.0527 (0.0000)	0.3429 (0.0000)	0.6791 (0.0000)	0.4072 (0.0000)			
Replacement capital	0.0647 (0.0000)	0.3534 (0.0000)	0.6952 (0.0000)	0.4350 (0.0000)	0.9992(0.0000)		
Inflation	0.0007 (0.8779)	0.0128 (0.0051)	0.0407 (0.0000)	0.0170 (0.0002)	−0.0578 (0.0000)	−0.0577 (0.0000)	
	EVA difference	Inflation	Debt ratio	PPE ratio	Debt ratio × inflation	PPE ratio × inflation	Asset life
Panel B, correlations between variables used in regressions							
Inflation	0.3297 (0.0000)						
Debt ratio	0.0889 (0.0000)	0.0254 (0.0000)					
PPE ratio	−0.0142 (0.0018)	0.0367 (0.0000)	0.7911 (0.0000)				
Debt ratio × inflation	0.1732 (0.0000)	0.1233 (0.0000)	0.9701	0.7706 (0.0000)			
PPE ratio × inflation	−0.0032 (0.4870)	0.0833 (0.0000)	0.9253 (0.0000)	0.8610 (0.0000)	0.9195 (0.0000)		
Asset life	0.0463 (0.0000)	0.2152 (0.0000)	0.1266 (0.0000)	0.1773 (0.0000)	0.1526 (0.0000)	0.1442 (0.0000)	
Past inflation	−0.0489 (0.0000)	0.5171 (0.0000)	0.0633 (0.0000)	0.0833 (0.0000)	0.1179 (0.0000)	0.1831 (0.0000)	0.5946 (0.0000)

The following presents correlation coefficients between major variables. For Panel A see the variable description in Table 1 for more information. For Panel B, $EVADIFF = (\text{real EVA}/\text{replacement capital}) - (\text{nominal EVA}/\text{capital})$. $NETDEBT$ ratio is the sum of the firms nominal liabilities minus its nominal assets divided by capital. PPE ratio is property plant and equipment divided by capital. Asset life is the estimated average life of the firm's assets. Past inflation is the total percentage change in the GDP deflator over the estimated asset life of the firm. P -Values are presented in parenthesis.

Table 4

Firm fixed effects regressions of the difference between real and nominal EVA on inflation, leverage and asset base

	Full sample		1990s onwards	
	Model 1	Model 2	Model 3	Model 4
Intercept	−0.0125*** (−69.88)	−0.0106*** (−23.93)	−0.0120*** (−39.46)	−0.0104*** (−32.09)
Inflation	0.3515*** (66.27)	0.2978*** (24.22)	0.4928*** (35.63)	0.4383*** (31.50)
NETDEBT ratio	0.0012 (1.30)	–	0.0065*** (4.99)	–
PPE ratio	−0.0014 (−0.92)	–	−0.0058*** (−3.81)	–
NETDEBT ratio × inflation	–	0.5005*** (4.94)	–	0.6099*** (6.21)
PPE ratio × past inflation	–	−0.0234*** (−4.68)	–	−0.0253*** (−5.42)
Asset life/1000	−0.0001** (−2.53)	−0.0002*** (−4.53)	−0.0006***	−0.0006*** (−13.84)
Past inflation	−0.0211*** (−24.84)	−0.0103*** (−3.96)	−0.0087*** (−7.09)	−0.0002 (−0.08)
<i>N</i>	47979	47979	26432	26432
<i>R</i> ²	0.1345	0.2397	0.1038	0.2018

The dependant variable is $EVADIFF = (\text{real EVA}/\text{replacement book}) - (\text{nominal EVA}/\text{book equity})$. Inflation is the annualized change in the GDP deflator. NETDEBT ratio is the sum of the firms nominal liabilities minus its nominal assets divided by book equity. PPE ratio is property plant and equipment divided by book equity. Asset life is the estimated average life of the firms assets. Past inflation is the total percentage change in the GDP deflator over the estimated asset life of the firm. Models 1 and 2 use data from 1976 to 2002, while models 3 and 4 use data from the 1990s only. White (1980) corrected *t*-stats of the two tailed test that the coefficients are zero are in parenthesis. The regressions control for firm level fixed effects. *Significant at 10% level.

** Significant at 5% level.

*** Significant at 1% level.

more clearly by recalling that $EVA = NOPAT - wacc \times \text{capital}$. Dividing both sides by book equity yields $EVA/\text{capital} = NOPAT/\text{capital} - wacc$. An analogous transformation applies to real EVA.

The correlations indicate that the difference between the real and nominal EVA appears to be strongly related to inflation. There is also evidence of high levels of correlation between some of the independent variables (for example, the debt ratio and the PPE ratio). Such levels of correlation may lead to multicollinearity issues in the regression analysis.

Table 4 presents regressions of the difference between real and nominal EVA on inflation, leverage and asset characteristics. In model 1, I examine the relation between the difference in real and nominal EVA and the factors that are hypothesized to cause the difference. Inflation is positive and highly significantly related to the difference in EVA implying that higher inflation leads to greater downward distortions on nominal EVA. This relation can clearly be seen graphically in Fig. 2, which shows the annual mean EVA difference and the corresponding inflation rate.

Both the nominal liabilities (as measured by the debt ratio) and the firm's fixed assets (measured by the PPE ratio) are not significantly related to $EVADIFF$. This may appear to contradict my hypothesis that the firm's debt and asset based should lead to distortions in EVA however the distortions depend not only on the amount of the debt or assets, but

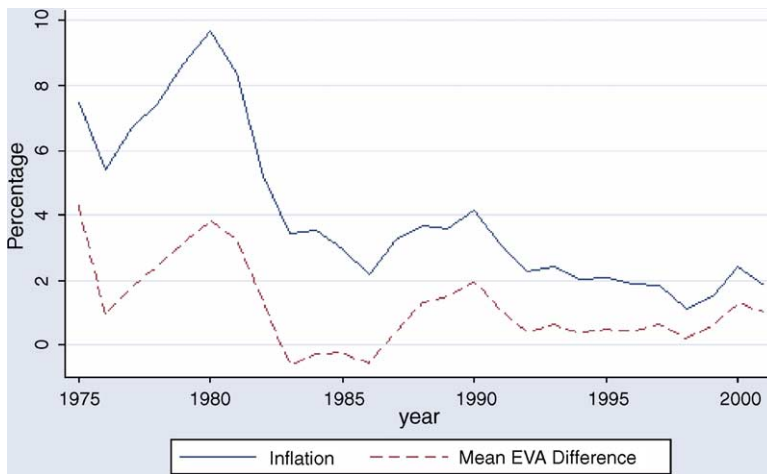


Fig. 2. Inflation and difference between real and nominal EVA.

also the amount of inflation. The asset life variable, which measures the average age of the firm's assets, is negatively related to EVADIFF. Firms that have younger assets will have smaller depreciation adjustments and replacement capital closer to reported capital. The coefficient on past inflation is negative and significant indicating that past inflation reduces the difference as it results in higher replacement book values and greater depreciation adjustments—both of which offset some of the effects of current inflation.

A key aspect of the distorting effects of inflation on EVA is that most of the distortions occur through the interaction of inflation (or past inflation) and some other financial characteristic. In fact the only way in which inflation acts alone is through the cost of capital. In model 2, I attempt to capture these combined effects through the use of interaction variables. Model 2 includes NETDEBT ratio interacted with inflation to capture the combined effect of these variables on the debt adjustment. This new variable is positive and highly significant. The coefficient on the inflation variable is reduced with the addition of the NETDEBT variable. For firms with zero NETDEBT, the effect of inflation is captured in this variable alone. Model 2 also includes an interaction variable for PPE and past inflation, which is negative and significant, consistent with firms that have more assets and higher inflation over the life of the assets having a bigger depreciation adjustment.

In models 3 and 4, I repeat the set up of models 1 and 2, but this time I examine the sub period from the 1990s onwards. During this period, inflation was lower and less volatile than during the earlier part of my sample. A valid criticism of the full sample results is that they are not applicable in the low inflation environment the US currently enjoys however, from models 3 and 4, we see that inflation remains a significant determinant of the difference between real and nominal EVA.

The raw correlation coefficients presented in Panel B of Table 3 suggest that there may be some multicollinearity in the regression specifications used in Table 4. Although multicollinearity does not result in biased estimators, it can reduce the significance levels

of the individual coefficients. An examination of the variance inflation factors (see [Greene, 2000](#)) for the four regression models indicates that model 2 may suffer from multicollinearity with the offending variables being PPE ratio \times past inflation and debt ratio \times inflation. The variance inflation factors for these two variables are 10.92 and 10.84, respectively. The inverse of the variance inflation factor is the proportion of the variation in these variables that is not explained by the other right-hand side variables. For these two variables $1/VIF$ is 0.0915 and 0.0923. In unreported regressions, when one of the two variables is removed from model 2, the other variable becomes insignificant. This is consistent with these two variables having a strong negative correlation and when one is removed the remaining variable attempts to capture both opposing variable's effects, resulting in insignificance. Therefore, in this case it seems to make more sense to leave both variables in the model.

From a manager's perspective a key aspect of EVA is how well it measures firm performance and how can this be translated in to compensation packages for employees. For EVA to be an effective employee motivator, major changes in EVA should be due to firm performance and not due to external factors over which the employee (or the firm) have no control. Inflation is one of these potential external factors. In [Table 5 I](#) examine the sensitivity of real and nominal EVA to changes in inflation and other firm characteristics. The change in nominal EVA is measured as:

$$\text{nominal EVA change} = \text{nominal EVA}_t - \text{nominal EVA}_{t-1} \quad (18)$$

Likewise, the change in real EVA is measured as:

$$\text{real EVA change} = \text{real EVA}_t - \text{real EVA}_{t-1} \quad (19)$$

The first model in [Table 5](#) examines the effect of changes in inflation, NOPAT, and capital on EVA. The coefficient on inflation is a highly significant, -750 . In economic terms, this means that for the average firm, a 100 basis point increase in inflation reduces EVA by US\$ 7.5 million. This negative effect primarily occurs because the nominal required rate of return used in the nominal EVA computation is increasing by the rate of inflation (i.e. $r+p$), while the firm's NOPAT is increasing by one plus the inflation rate (i.e. $1+p$). This actually strikes at a fundamental problem of a nominal EVA metric—it attempts to measure a one period income return (NOPAT) against a required return that incorporates income and future growth expectations. As a robustness check, I examine the relation in the 1990s sub period in model 2. Here the inflation coefficient is a negative, -1008 , and implies a US\$ 10 million reduction in EVA for a 100 basis point increase in inflation. The higher coefficient in the 1990s than in the full sample is likely a result of EVA being expressed in current year dollars, rather than a constant year measure. The remaining coefficients in the table control for changes in the level of NOPAT and capital and have the expected relation with nominal EVA.

In models 3 and 4, I examine the impact of the same variables on change in real EVA. Here, I find that real EVA is actually positively affected by a change in inflation. The coefficient is a significant $+567$. This result may appear surprising as one might expect real EVA to be inflation neutral. In fact inflation has a positive effect on the value of levered firms that pay taxes. This is because while the nominal portion of the firm's interest expense

Table 5
Firm fixed effects regressions of change in real and nominal EVA on changes of major components of EVA and inflation

	Change in nominal EVA		Change in real EVA	
	Full sample	1990s onwards	Full sample	1990s onwards
Intercept	−1.4851*** (−3.49)	−1.2909* (−1.75)	1.1216** (2.49)	2.2505 (2.81)***
Change in inflation	−750.2607*** (−18.99)	−1008.2570*** (−6.84)	566.6035*** (15.85)	1757.8160*** (12.15)
Change in NOPAT	1.0637*** (41.29)	1.0622*** (35.26)	1.0713*** (42.32)	1.0825*** (39.09)
Change in capital	−0.0682*** (−19.32)	−0.0691*** (−19.32)	–	–
Change in replacement capital	–	–	−0.0494*** (−11.22)	−0.0500*** (−11.69)
<i>N</i>	40608	22320	40608	22320
<i>R</i> ²	0.9747	0.9751	0.9684	0.9676

The dependant variables are the change in nominal EVA and the change in real EVA. Change in nominal EVA is measured as, nominal EVA_{*t*} − nominal EVA_{*t*−1}. Change in real EVA is measured as, real EVA_{*t*} − real EVA_{*t*−1}. Change in inflation is, inflation_{*t*} − inflation_{*t*−1}. Change in NOPAT is, NOPAT_{*t*} − NOPAT_{*t*−1}. Change in capital is, capital_{*t*} − capital_{*t*−1}. Change in replacement capital is, replacement capital_{*t*} − replacement capital_{*t*−1}. The full sample uses data from 1976 to 2002, while the 1990s onwards sample is from 1990 to 2002. White (1980) corrected *t*-stats are in parenthesis. The regressions control for firm level fixed effects.

* Significant at 10% level.

** Significant at 5% level.

*** Significant at 1% level.

is tax deductible, the debt capital gain that the firm gets (measured by the debt adjustment) is not taxed under the current tax code. In effect the firm gets $t \times p \times D$ (where t is the tax rate, p the inflation, and D is the debt) gain as this is the portion that would be paid in taxes if the debt gain was taxed in the same way as other income. The results of model 4 (for the 1990s) indicate that the relation also holds in the later sub period.

The implications of Table 5 are important for all adopters of EVA—particularly those in a low inflation environment. An increase in inflation will result in a decline in EVA (holding all else equal). Furthermore, firms operating in volatile inflation environments will see significant fluctuations in EVA which have little to do with firm performance and a lot to do with the changes in the inflation rate. This last point is important given that adopters of EVA are encouraged to focus on changes rather than absolute levels. For example, Stewart (1991) states: “All it takes is to recognize that value is created at the margin, by looking forward, not by looking backward at the distortions created by past inflation”.¹¹ What this statement fails to recognize is that the marginal change in EVA is not immune to inflation distortions either.

It might be argued that also based on Table 5, real EVA is no better in that it too is heavily influenced by inflation. This is true but the difference between inflation’s effect on nominal EVA and real EVA is that for real EVA the additional gains due to inflation are true economic gains, whereas for nominal EVA the losses in EVA due to inflation are actually due to mis-measurement and do not represent true economic losses.

5. Conclusions

Building upon the work of De Villiers (1997), I argue that inflation has significant distorting effects on EVA as traditionally computed. These distortions are caused primarily through the use of accounting numbers, which fail to take account of the understatement of depreciation expense for firms following periods of inflation and from the real depreciation of nominal debt that serves to benefit levered firms during times of inflation. Furthermore, EVA is measured as the excess of the accounting return over the required return of investors. This required return is based on nominal rates, which are very sensitive to inflation, as well as book equity capital, which fails to take account of the true replacement cost of the firm’s assets.

Overall inflation appears to create downwards distortions to conventionally reported EVA. However, for the individual firm the level of the distortion will depend greatly on its leverage (which will tend to distort EVA lower) and its amount and age of real assets (which coupled with past inflation will tend to distort EVA higher).

I propose an alternative EVA metric “real EVA” which explicitly adjusts for these distortions. Empirical tests on a large sample of US firms indicate that inflation has a positive effect on real EVA and a negative effect on nominal EVA. Analysts, managers, and investors who attempt to gauge firm performance using EVA should be aware of the distortions that inflation causes. While this paper proposes a corrected version of EVA it may not be practical

¹¹ p. 227, “*The Quest for Value*”.

in many cases for managers to make the adjustments that I present. This presents firms with a difficult decision, particularly in high inflation environments—either attempt to employ fairly complex computations to correct EVA or use a measure of EVA that is sure to have significant distortions.

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Appendix A. Default spreads and bond ratings used in the estimation of the cost of debt

The default spreads and synthetic ratings are from Damodaran (2002). Interest coverage is operating income divided by interest expense.

Interest coverage ratio	Synthetic rating	Spread over BBB rated debt
>8.50	AAA	For these ratings, I use the average yield on newly issued debt
6.50–8.50	AA	
5.50–6.50	A+	
4.25–5.50	A	
3.00–4.25	A–	
2.50–3.00	BBB	
2.00–2.50	BB	0.50%
1.25–2.00	B	1.75%
0.80–1.25	CCC	3.50%
0.65–0.80	CC	4.50%
0.20–0.65	C	6.00%
<0.65	D	8.50%

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