

Modernization of the Economic Price Adjustment Software

Roger L Goodwin

Abstract: The US Consumer Price Indices (CPIs) measures hundreds of items in the US economy. Many social programs and government benefits index to the CPIs. The purpose of this project is to modernize an existing process. This paper will show the development of a small, visual, software product that documents the Economic Price Adjustment (EPA) for long-term contracts. The existing workbook does not provide the flexibility to calculate EPAs where the base-month and the option-month are different. Nor does the workbook provide automated error checking. The small, visual, software product provides the additional flexibility and error checking. This paper presents the feedback to project.

Keywords

Consumer Price Index, Economic Price Adjustment, contracts, visualization tools, database, reports, forms, event procedures

I. INTRODUCTION

IN the mid to late 1990, much research appeared in the literature on the US Consumer Price Index. What was the motivation? In 1996, a final report from an Advisory Committee of the US Senate Finance Committee to study the Consumer Price Index appeared [2]. The Advisory Committee report is sixty-nine pages long and contains fifteen recommendations.

We will discuss some background and research on the Consumer Price Index in this section.

Reference [5] outlines a history of the estimators of the index of prices upon which the US Consumer Price Indices rely on. Table I summarizes the history of the index of prices research. We will simply mention the different approximations used in practice for the index of prices and the assumptions. Table II summarizes the estimators derived from the Divisia Theoretical Index [5].

Reference [8] presents research on the current CPI Indices at the Bureau of Labor Statistics used at the time. The authors present research on alternative estimators to the modified Laspeyres estimator that BLS use. Their research involves experimental CPIs using the geometric mean estimator and different target populations based on age and poverty. Reference [6] presents research on social cost of living indices. The authors discuss two concepts:

- Econometric model of consumer behavior.
- Welfare functions.

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TABLE I. INDEX OF PRICES HISTORY

| Year | Author | Concept | Comment |
|------|------------------|--------------------------|---|
| 1887 | Alfred Marshall | Chain-index of prices | First suggested the idea |
| 1925 | Francois Divisia | Index of prices | Changes over time |
| 1966 | Marcel Richter | Index of prices | Technology change |
| 1962 | United Kingdom | Index of Retail Prices | Weights change every year (actual implementation) |
| 1971 | France | Index of Consumer Prices | Weights change every year (actual implementation) |

TABLE II. ESTIMATORS OF THE INDEX OF PRICES

| Estimator / Estimate | Concept | Comment |
|------------------------------|---|--|
| Divisia's Theoretical Index | Law of circulation of money | Multiplicative relations of individual items |
| Geometric Mean Approximation | Approximation to the continuous index | Every commodity obeys the same assumed price / quantity law |
| Laspeyres Approximation | Same as geometric mean without the logarithms | All goods have zero price elasticity in the interval |
| Paasche Approximation | Uses the backward interval in time | All goods have zero price /quantity elasticity in the interval |
| Fisher Ideal Formula | Geometric mean of Laspeyres and Paasche | Does not assume any price / quantity law. |

The authors define a *social cost of living index* for a group of households to maintain a given standard of living. With the social cost of living index, the authors define the social welfare function for computation purposes. The commodities in the index must be constant in quantity. The authors define a group cost-of-living index. The authors argue that health care prices affect elderly households more so than non-elderly households, as an example. The authors go on to define a gender-based index, too. The authors present numeric results with their research. Reference [7] presents research on bias in a consumer price index using the Netherland's Central Bureau of Statistics' survey data.

This is some of the published research generated from the Advisory Committee recommendations. The *American Statistical Association's Annual Conference* certainly has more research on the CPI. The rest of this paper will discuss the modernization of the Economic Price Adjustment (EPA) of

contract prices at the Government Printing Office. In addition, aside from fundamental changes in the economy, any changes to the CPI estimator will affect the EPAs.

II. PRACTICAL USES OF THE CPI

Reference [6] lists the following US programs that index using the CPI:

- Social Security.
- Supplementary Security Income.
- Military Retirement.
- Civil Service Retirement.
- Railroad Retirement.
- Veterans' compensation and pensions.
- The IRS' individual income-tax brackets and the personal exemption.

Do not assume this is a comprehensive list. For instance, the US Treasury sells I Series savings bonds. The rate of return on those savings bonds relies, in part, on the CPI. This paper adds another agency program, albeit not a social program, to the list that adjusts using the CPI.

The US Government Printing Office uses Economic Price Adjustments (EPAs) to reflect changes in prices affecting the materials that go into long-term contracts — not as a reward for good work. These contracts are long-term, in nature, typically ranging from three to five years. Contracts with EPA clauses explicitly state such terms and agreements. Out of the hundreds of CPIs that the Bureau of Labor Statistics publishes, GPO uses TABLE 2, THE SPECIAL CATEGORY, THE COMMODITIES LESS FOOD INDEX. In the past, GPO would get the CPI from the trade publication *Printing Impressions*. Unfortunately, *Printing Impressions* stopped publishing the CPI decades ago. In 2012, BLS moved the web page for TABLE 2, THE SPECIAL CATEGORY, THE COMMODITIES LESS FOOD INDEX.

We define the base year of the contract as the first year of the contract. By default, contractors' state the current economic conditions for the base year. Therefore, EPAs do not apply. We define succeeding years as option years. EPAs apply. Both the US Government Printing Office and the contractor must agree to extend the contract. During option years, the contract can close if either side balks at the terms. EPAs can be both positive and negative.

During the run-up to 2008 financial crisis, the EPAs were positive. As the indices rose, so did the EPAs. Those same contracts after the 2008 crises had negative EPAs because the CPIs consistently dropped below the base year. This generated more communication between contractors and the US Government Printing Office (GPO) over the EPA calculation. To answer many questions, it became apparent that there are many guesses from company presidents, company vice-presidents, LLCs, CPAs, and accountants as to how GPO calculates the EPA for their contract.

That single percentage called the EPA is an average of two averages of twelve CPIs each. The base-year has twelve CPIs.

These do not change over the life of the contract. Each option-year has twelve CPIs, averaged. These change from year-to-year. The adjustment is based on the Consumer Price Index (CPI) published by the Bureau of Labor Statistics each month. The calculation is as follow:

$$\text{EPA Adjustment} = \frac{(X - B)}{B} \times 100 \quad (1)$$

where X is the average of 12 monthly CPI indices called the *option year* and B is another average of 12 monthly CPI indices called the *base year*. The contract states when the base date begins and ends. It also states when each option-year begins and ends.

Traditionally, when GPO receives a request for an EPA adjustment, GPO refers to an Excel workbook. The workbook contains columns for four option years. The months from 1983 to the present go down the rows. It is limited to adjustments where the base-month and the option-month are identical. GPO must calculate, by hand, the EPA for contracts that have different base and option-year months using (1).

III. VISUAL IMPLEMENTATION AND CONSIDERATIONS

This paper will present an MS Access form that displays an EPA Adjustment Calculator. Event procedures calculate the averages X , B , and the EPA adjustment. Additionally, event procedures calculate and display error messages. MS Access stores the CPI Indices in an MS Access table. The MS Access Form has the following advantages over the existing Excel workbook.

- 1) Can calculate adjustments where the base month and the option month are not the same.
- 2) Has automated error checking and displays a message. For example, most contracts cannot exceed 4 option years.
- 3) Has a User's Guide to accompany the Calculator.

Reference [9] discusses the use of FinVis, a visual analytics tool, for non-expert financial users. Reference [1] discusses programming in VBA for Excel to extend its capabilities. MS Office comes with three main software products:

- 1) MS Word
- 2) MS Excel
- 3) MS PowerPoint

Consumers must purchase MS Access outside of this bundle. All four of these products have VBA programming environments. If the application were heavy with words, sentences, fonts, etc.; then the VBA environment to program in would most likely be MS Word. The next section will show the development tools available in MS Access.

IV. ACCESS TOOLS

MS Access provides several tools for application development. The tools include:

- Tool box.
- Wizards.
- Property Window.

- Intellisense.

Each functional object in the Tool box in 1 has its own Wizard. These Wizards set the default values and names of the object. For instance, our list box for the beginning base date uses the field `Display Date` from the Access table `tblCPIndices2`. The Wizard is a point-and-click environment that makes setting such properties easy. Figure 2 shows the first screen to the List Box Wizard. To correctly set the list box properties by hand would be phenomenal.



Fig. 1. This figure shows the Tool Box in the Design View when building the Access form.

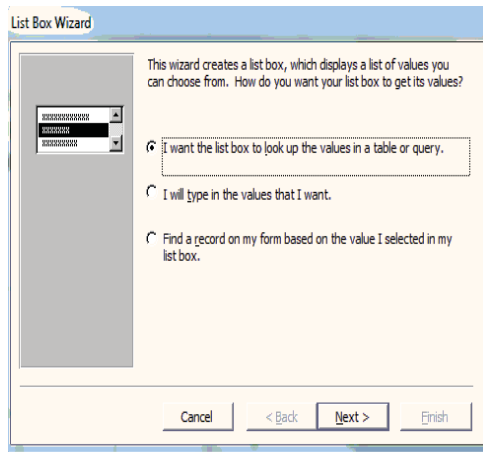


Fig. 2. This figure shows the Access List Box Wizard. It is displayed after selecting the list box control from the Tool Box.

Each control object has its own set of properties. These can be changed and modified in the Properties Window in 3. Instead of using programming steps, it is easier to set the properties here. For instance, it is not necessary to write code to bold text in a text box. There are several events listed in the Property Window. On `Single Click` is the one used in this application. Other events include:

- Before update.
- After update.
- On enter.
- On exit.
- On double click.
- On mouse down.
- On mouse up.

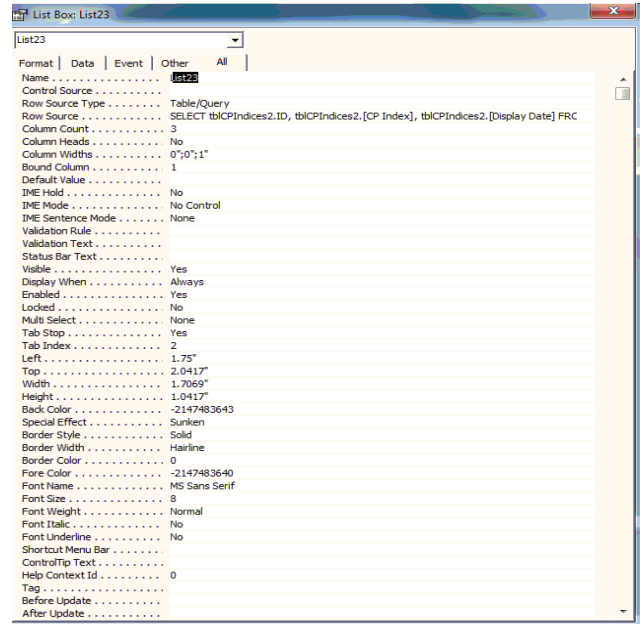


Fig. 3. This figure shows the Property Window associated with the list box `list23`.

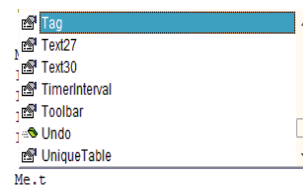


Fig. 4. This figure shows Intellisense in the VBA programming environment. When controls are created, Access adds them to the Intellisense menu.

- On mouse move.
- On key down.
- On key up.

Programming events allows the developer to create custom applications that could not otherwise be easily accomplished using the tools given so far. The programming environment is similar to that of a Visual Basic editor in that the developer must know the syntax of the programming language. The advantage of VBA is that it comes with Intellisense shown in 4. When new objects are added to the application, they automatically appear in Intellisense. Intellisense automatically appears when typing programming statements.

V. THE CALCULATOR DISPLAY

A typical request for an EPA will come via email with or without a contract attached. In the case that a contract is attached, then determining the beginning date for the base year is fairly straight forward. It does take an effort to ensure that the EPA clause is consistent with the first paragraph of the contract, though. In the case that a contract is not attached, the requestor states the contract beginning base date. The option

Fig. 5. This figure shows the display to the EPA Calculator, Version 2.

date may be implied or explicitly stated. In either case, a base year date is the starting point and must be selected. Minimally, the option year beginning date must also be selected. Requests for adjustments for dates prior to today's date as an option are common. Some Requests will go back 3 to 4 years for verification purposes.

Let's start with the calculator and dissect it. The calculator is shown in 5. Functionally, it contains 2 text boxes, 2 list boxes, and 2 push buttons.

Text Boxes: One of the 2 text boxes can be found in the upper-right corner of the calculator. It shows the value of the EPA Adjustment. The second text box appears at the bottom of the screen above the push button. It displays any error messages and warnings. Both boxes are filled after the push button has been clicked.

List Boxes: The two list boxes appear in the middle of the calculator. The values are the beginning dates for the contract base year and the option year. The values for both of these lists come from the table that contains the CPI indices. Upon a single click in the left list box, the average B is calculated. Likewise, upon a click in the right list box, the average X is calculated. Both events have been written in Visual Basic for Applications.

Push Buttons: Two push buttons appear at the bottom of the screen. One is labeled "Calculate." The other is labeled "Print Report." Upon a single click of the "Calculate" push button, the event procedure calculates the EPA adjustment in (1) using X and B . It also performs some error checking for contract date inconsistencies. In addition to contract inconsistencies, the user may not have clicked on a base date. This would result in an error message because it results in division by zero.

Upon a single click of the "Print Report" push button, the software creates a two-page report. Figure 7 shows the twelve CPIs for the base year and the average. Figure 8 shows the twelve CPIs for the option year and the average. In addition, the software shows the EPA calculation.

VI. THE ACCESS TABLE

| ID | Year | CP Index | Display Date |
|-----|------|----------|--------------|
| 289 | 2007 | 151.3 | 01-Oct-07 |
| 290 | 2007 | 151 | 01-Nov-07 |
| 291 | 2007 | 149.4 | 01-Dec-07 |
| 292 | 2007 | 149.5 | 01-Jan-08 |
| 293 | 2007 | 150.3 | 01-Feb-08 |
| 294 | 2007 | 154 | 01-Mar-08 |
| 295 | 2007 | 155 | 01-Apr-08 |
| 296 | 2008 | 155.7 | 01-May-08 |
| 297 | 2008 | 154.9 | 01-Jun-08 |
| 298 | 2008 | 155.5 | 01-Jul-08 |
| 299 | 2008 | 155 | 01-Aug-08 |
| 300 | 2008 | 156.8 | 01-Sep-08 |
| 301 | 2008 | 160.6 | 01-Oct-08 |
| 302 | 2008 | 162.7 | 01-Nov-08 |
| 303 | 2008 | 160.9 | 01-Dec-08 |
| 304 | 2008 | 160.3 | 01-Jan-09 |
| 305 | 2008 | 154.9 | 01-Feb-09 |
| 306 | 2008 | 145 | 01-Mar-09 |
| 307 | 2008 | 140.2 | 01-Apr-09 |
| 308 | 2009 | 141.3 | 01-May-09 |
| 309 | 2009 | 143.3 | 01-Jun-09 |
| 310 | 2009 | 142.8 | 01-Jul-09 |
| 311 | 2009 | 142.8 | 01-Aug-09 |
| 312 | 2009 | 143.5 | 01-Sep-09 |
| 313 | 2009 | 147.4 | 01-Oct-09 |
| 314 | 2009 | 147.6 | 01-Nov-09 |
| 315 | 2009 | 149.3 | 01-Dec-09 |
| 316 | 2009 | 150 | 01-Jan-10 |
| 317 | 2009 | 151.1 | 01-Feb-10 |
| 318 | 2009 | 153.1 | 01-Mar-10 |

Fig. 6. This figure shows the Access Table that stores the data. The columns ID, CP Index and Display Date are used by the calculator

Figure 6 shows a partial view of the Access table. The table stores the dates and the CPI indices. These dates are display dates used in Section V. They differ from the Bureau of Labor Statistics dates by 3 months because of the contract verbiage. The EPA Calculator relies heavily upon the auto-numbers assigned to the records by Access. When a new CPI is added to the table, Access increments the index by a value of 1. This relation is important when calculating the base index B and the option index X because months are consecutively ordered.

VII. THE EVENT PROCEDURES

The event procedures are written in Visual Basic for Applications (VBA). They are triggered by a single click of the mouse and are not excessively complex. Once the user selects the start date of the contract, the calculator averages the last 12 consecutive CPI indices from that date and inclusive of the date selected. The function `DAvg` averages those numbers using the ID variable. The syntax to the `DAvg` function has 3 parameters:

`DAvg(expr, domain, [criteria])`

where the expression is the field that contains the numbers to be averaged. The domain is the name of the Access table. The third argument, the criteria, is used to restrict the range of the data. The user does not notice any drag on the response time when selecting from the list boxes due to the `DAvg` function.

A. Base Index

The subroutine in this section is written using the Properties Window tool. MS Access assigns a name to the subroutine for the programmer in VBA. The actual program code is as follow:

```
Private Sub List23_Click()

    'get the position of the start
    bStartID = Me.List23.Column(0)

    'go back 12 months
    bEndID = bStartID - 11

    'calculate the epa base average
    bEpa =
    DAvg("[CP Index]", "tblCPIIndices2",
    "[ID]>=" & bEndID & "and [ID] <=" &
    bStartID)

End Sub
```

The list box name for displaying the base start dates is List23. The name of the field that we are averaging is CP Index. The name of the Access table is tblCPIIndices2. Finally, the ID field is restricted using the choice that the user clicked (bStartID). The other program variable, bEndID, is equal to bStartID minus 11.

B. Option Index

Likewise, the subroutine in this section is written in VBA with the help of the Properties Window. The calculation of the option year index is very similar to that for the base year index. The option year does need to be at least one more than of the base year. Otherwise, the mechanics for calculating the average of 12 CPI indices are the same. The actual program code is as follow:

```
Private Sub List25_Click()

    'get the position of the start date
    oStartID = Me.List25.Column(0)

    'go back 12 months
    oEndID = oStartID - 11

    'calculate the epa option average
    oEpa =
    DAvg("[CP Index]", "tblCPIIndices2",
    "[ID]>=" & oEndID & "and [ID] <=" &
    oStartID)

End Sub
```

The list box name for displaying the option start dates is List25. Again, we average the field CP Index in the table tblCPIIndices2. The condition on the last line restricts the average to 12 months using the 2 program variables oStartID and oEndID.

C. EPA Calculation

As stated earlier, the formula for the Economic Price Adjustment (EPA) for a contract is given in (1). Given the variables bEpa and oEpa, it is now possible to calculate the EPA for a contract. The base index B corresponds to the program variable bEpa and the option index X corresponds to the program variable oEpa.

```
Private Sub Command29_Click()

    'error message calculations
    ....

    'calculate the final EPA
    If (bEpa > 0) Then
        Epa=(oEpa-bEpa)/bEpa*100

    'display the EPA
    Me.Text27.Value = Epa

    'display the error messages
    Me.Text30.Value = ""
    If Note1 <> "" Then
        Me.Text30.Value = Note1
    If Note4 <> "" Then
        Me.Text30.Value = Note4
    If Note2 <> "" Then
        Me.Text30.Value = Note2
    If Note3 <> "" Then
        Me.Text30.Value = Note3

End Sub
```

The push button name called Calculate is Command29. The logic behind the error messages have been intentionally omitted. The EPA calculation for the contract follows the formula $(X - B)/B \times 100$ and is displayed in the text box in the upper-right corner of the screen. That text box is called Text27. Any error messages are displayed in the text box called Text30.

VIII. UPGRADE AND DOWNGRADE ISSUES

Upgrade and downgrade issues arise when the underlying software support changes. For instance, the software presented in this paper is developed in MS Access 2003; but has been upgraded in MS Access 2007. Not all of the target computers upgraded to MS Access 2007. Conversion issues arose. Some will be discussed here.

- On the upgrade, a new security feature was added to MS Access 2007. The user must click on a radio button to allow the calculator (Access form) to run. This needed to be included in the documentation.
- On the downgrade, on-click procedures did not recognize their respective source code. This is an easy fix. Just go through the dialog box in MS Access and it will find the correct procedure. This must be manually done.
- On the downgrade, the source code uses keyword options that are no longer supported; intellisense will show this to the programmer. Knowing what piece of source code is causing the problem may or may not be an issue depending on the modularity, complexity, and length of the program. Since we are using objects that are event driven in this paper (two list boxes and a push button), it was not that big of an issue.

Those have been the 3 issues discovered so far with working with visual tools.

IX. DOCUMENTATION

Users' of this small software product are more interested in the outputs than the implementation details. Documentation to orient them has been written. The User's Guide contains 4 sections and 14 pages.

- 1) Introduction — This section gives an overview of the calculator inputs. It gives 3 progressively difficult examples for defining the base year beginning date and the option year beginning date.
- 2) Using the Calculator — This section contains screen captures of MS Access and the EPA Calculator. It lists the steps to successfully calculate an EPA.
- 3) Printing and Saving — This section shows how to take a screen capture of the calculator results and print. This is necessary for documenting the contract.
- 4) Examples — This section contains numeric examples from the Introduction with screen captures.
- 5) Error Messages — This section lists the predefined 4 error messages and 1 warning message.

X. RESULTS

This small, visual, software product became available to the US Government Printing Office employees via the intranet during the summer of Fiscal Year 2010. GPO obtained the following comments and results after making the calculator available:

- It gives the regional offices autonomy and "self-empowerment."
- There are less errors in issuing the EPAs.
- The service is quicker.
- There is a noticeable drop in EPA requests coming into the servicing business unit.

Economic Price Adjustment Calculator v2.0
Base Year Consumer Price Indices

| Contract Period | Consumer Price Index |
|-----------------|-------------------------|
| 31-May-07 | 151.6 |
| 30-Jun-07 | 151.3 |
| 31-Jul-07 | 151 |
| 31-Aug-07 | 149.4 |
| 30-Sep-07 | 149.5 |
| 31-Oct-07 | 150.3 |
| 30-Nov-07 | 154 |
| 31-Dec-07 | 155 |
| 31-Jan-08 | 155.7 |
| 29-Feb-08 | 154.9 |
| 31-Mar-08 | 155.5 |
| 30-Apr-08 | 155 |
| Average | 152.766666666667 |

1. The last date in the list represents the interval ending 3 months from the beginning date of the contract, called the base index.

Fig. 7. This figure shows page 1 of the EPA calculation. There are twelve CPIs and an average at the bottom of the page for the base year.

Economic Price Adjustment Calculator v2.0
Option Year Consumer Price Indices

| Contract Period | Consumer Price Index |
|-------------------|---|
| 31-May-09 | 143.5 |
| 30-Jun-09 | 147.4 |
| 31-Jul-09 | 147.6 |
| 31-Aug-09 | 149.3 |
| 30-Sep-09 | 150 |
| 31-Oct-09 | 151.1 |
| 30-Nov-09 | 152.1 |
| 31-Dec-09 | 152.7 |
| 31-Jan-10 | 154.3 |
| 28-Feb-10 | 153.8 |
| 31-Mar-10 | 153.5 |
| 30-Apr-10 | 152.5 |
| Average | 150.65 |
| Your EPA = | $\frac{150.650000 - 152.766667}{152.766667} * 100 = -1.4\%$ |

1. The last date in the list represents the 12-month interval ending three (3) months prior to the beginning of the period being considered for adjustment.

Fig. 8. This figure shows page 2 of the EPA calculation. There are twelve CPIs and an average at the bottom of the page for the option year. Also, the EPA calculation appears at the bottom of the page.

XI. RECENT DEVELOPMENTS

After delivery, two developments occurred. One development deals directly with the functionality of the software. The second development deals with the data source.

- 1) We added a "Print Report" option to the calculator. See 7 - 8. This option prints a two-page report. Figure 7 shows the twelve CPIs in the base year and the average. Figure 8 shows the twelve CPIs in the option year and the average. Also in 8, the software shows the EPA calculation. Contractors receive a two-page report showing how GPO calculated their EPA, upon request. The GPO business unit servicing the contracts has documentation on how the EPA was calculated.
- 2) The Bureau of Labor Statistics separated the CPI into two parts in 2012. TABLE 2, THE SPECIAL CATEGORY, THE COMMODITIES LESS FOOD INDEX. has moved on BLS' website.

XII. SUMMARY

The purpose of this project was to create a small, visual, software product that shows the contractor how their EPA was calculated. The visual interface has two inputs — the base period and option period (month and year for each period). The contract contains these two items. The single output is a two-page report showing how the EPA is calculated. Page 1 shows the base period calculation. Page 2 shows the option period calculation and the EPA calculation. We improved upon an Excel workbook for calculating Economic Price Adjustments (EPAs). The workbook did not provide the flexibility to calculate EPAs where the base month and the option month were not the same. It also did not provide

automated error checking. The small, visual, software product did provide the additional flexibility and error checking.

ACKNOWLEDGMENT

MS Access is a copyright product of Microsoft Corporation.

The Bureau of Labor Statistics (BLS) publishes the Consumer Price Indices. The indices can be found at <http://www.bls.gov/cpi/tables.htm>. EPA calculations use TABLE 2, THE SPECIAL CATEGORY, THE COMMODITIES LESS FOOD index at the bottom of the table. Additionally, CPIs' are rounded to one decimal place. Since 2012, BLS has revised their website and the presentation of the Consumer Price Index series.

The author thanks Kathy Swigert for training on EPA calculations and continuous support reviewing inconsistent contracts.

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Roger Goodwin holds a BS in Computer Science and an MS in Applied Statistics from Old Dominion University. He completed a certificate in Software Engineering Processes from Learning Tree. He completed the Project Management Professional certification from PMI. He authored several papers in IEEE conferences and two online journals that summarize his experiences in government. He authored papers in the North East SAS Users Group that describes some of the SAS code that he wrote.