The Postal Service Variability Ratio and Some Implications
Robert Cohen and John Waller

This paper first introduces the concept of the variability ratio and why it is being studied. Section 2 explains the factors that influence the ratio. Section 3 describes the major developments that have impacted its behavior from 1980 thru 2013. Section 4 describes the exogenous events that have affected the ratio and Section 5 does the same for costing methodology changes. Section 6 examines the behavior over time of the infra-marginal and fixed costs that were calculated in Report 2 of this series. Finally, Section 7 investigates implications of some findings from Reports 1, 2, and 3 produced under this contract with the Commission.

1. Introduction

The variability ratio is the ratio of the Postal Services' attributable to institutional costs. Changes to the ratio can be determined annually when the Postal Service's cost system produces estimates of these costs. Traditionally these changes were important to the PRC because they determined the percentage of total costs that the Commission had to assign judgmentally to the classes of mail based on the pricing factors in the Postal Reorganization Act. It was also important to Postal management because it determined the amount of flexibility it had when proposing pricing changes. Generally speaking, the PRC preferred higher levels of attributable costs while Postal management preferred lower levels. This resulted in many contentious disputes about costing methodology. Few observers ascribed much meaning to the resulting fluctuations in the ratio beyond those conflicts.

The ratio, however, has had significance beyond those parochial concerns. The direction of the ratio, historically, has been an indication of the financial health of the Postal Service. When institutional costs were increasing as a percentage of total costs, in general, volume was decreasing or changing to a lower cost mail mix. Declining volume perversely means fewer pieces to cover institutional costs (i.e. increased unit institutional costs) and a reversal of the Postal Service economies of scale. A lower cost mail mix can be accompanied by a lower unit overhead contribution to institutional costs as has been occurring during the steady decline in the percentage of First Class and the increase in the percentage of Standard in the mail mix over the period being studied (1980 through 2013.). Unless offset by volume increases, a lower-cost volume mix has generally meant that Postal finances were deteriorating. This, however, may no longer be the case. The new post-PAEA Postal Service has a thriving business in parcels and these have much different revenue characteristics than letters and flats. Consequently Postal revenue is

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behaving differently and is no longer as directly correlated with volume and volume mix.[1] Consequently, Postal finances are improving even though institutional costs are a growing percentage of total costs.

The ratio has appeared stable for more than a third of a century when intuition suggests that it should have been less so. Consequently, the PRC has sponsored this study to investigate the apparent stability of the variability ratio. The institutional portion of the ratio consists of a both fixed costs and a variable portion called infra-marginal (IM).[2] This paper investigates the extent to which it varies with volume and the influence of infra-marginal (IM) cost on institutional and total cost.

2. Factors that influence the Variability Ratio

A**.** Operational factors

The ratio measures the relative size of two components; institutional costs on the one hand and attributable costs on the other.[3] If we start at a point in time (period one) with given percentages of total costs that are attributable and institutional and we move to a subsequent point in time (period two), several factors will simultaneously determine a new ratio. We will consider them individually.

Volume

Assuming volume grows from period one to period two, *ceteris paribus*, variable costs will increase. The attributable portion of variable costs will increase and the fixed portion of institutional costs will not change. Thus, the ratio will increase, because attributable costs will have grown relative to institutional costs.

Volume mix

The volume mix or composition of the mail reflects the work content of the volume. For our purposes "volume mix" Is measured by the average unit attributable cost of the volume at a given point in time.

Weighted Volume

Weighted Volume is the sum of the volume of the various products weighted by the average unit attributable cost of the products. It reflects both mail mix and total volume. An increase in weighted

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[1] From 2011 through the first three quarters of 2014, volume fell 9.4 percent while revenue fell only 1.1 percent excluding estimated revenue from the exigency rate increase.

[2] IM costs are variable but do not vary at the margin. Report 1 and Report 2 of this series are in depth discussions of IM costs from a theoretical and quantitative viewpoint.

[3] The ratio changes when the percentage of total costs that are institutional or attributable changes. Of course, if either attributable or institutional cost changes then the other necessarily changes in an equal offsetting amount. Thus, to say that the percentages of institutional or attributable costs change, is equivalent to saying that the variability ratio changes.

volume means that attributable costs are increasing faster than institutional costs. A decrease in weighted volume means that institutional costs are increasing faster than attributable costs.

Productivity

Productivity increases will, in general, decrease attributable costs more than institutional costs since attributable costs are those that respond to changes in volume, and productivity is defined as the ratio of the volume of inputs to the volume of outputs.   Changes in productivity can be expected to primarily affect mail processing, either in the plant or the delivery unit as in-office time, because mail processing is almost entirely volume variable.[4]

B. Non-operational factors

Exogenous changes

Changes to the income statement for non-operational reasons will increase or decrease institutional cost and so, affect the ratio of attributable to institutional costs. The most frequent changes have been adjustments for prior- year workers compensation and for the retiree health benefit escrow required by the PAEA (and then modified by subsequent Congressional actions).

Cost methodology

Over the years the ratio has been affected by changes to the cost methodology that affect the way in which attributable costs are calculated. An example is the PRC first adopting and later dropping the single subclass stop methodology.[5] Methodological changes have caused notable changes in the ratio several times that are explored in Section 5.

Impact of nonoperational factors on the ratio

Changes to cost methodology and exogenous changes were frequent throughout the period being examined. These caused increases and decreases to attributable and institutional costs that for some of the years were not necessarily reflective of the underlying operations of the Postal Service. While the values of attributable and institutional costs may not exactly reflect operations of the Postal Service in any given year, the overall trends exhibited by the data series are more robust and reliable, and reflect underlying operational events that are described below.

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[4] This has been the case since 2000 when productivity began to meaningfully improve.
[5] The methodology was adopted in Docket R87-1 and later dropped in Docket R2006-1. It involved attributing access and load time of all deliveries that involved only one subclass.

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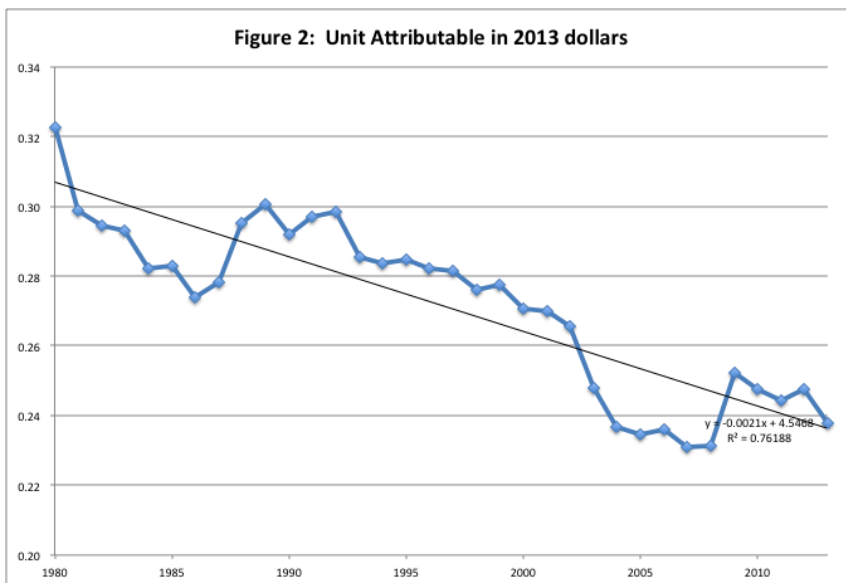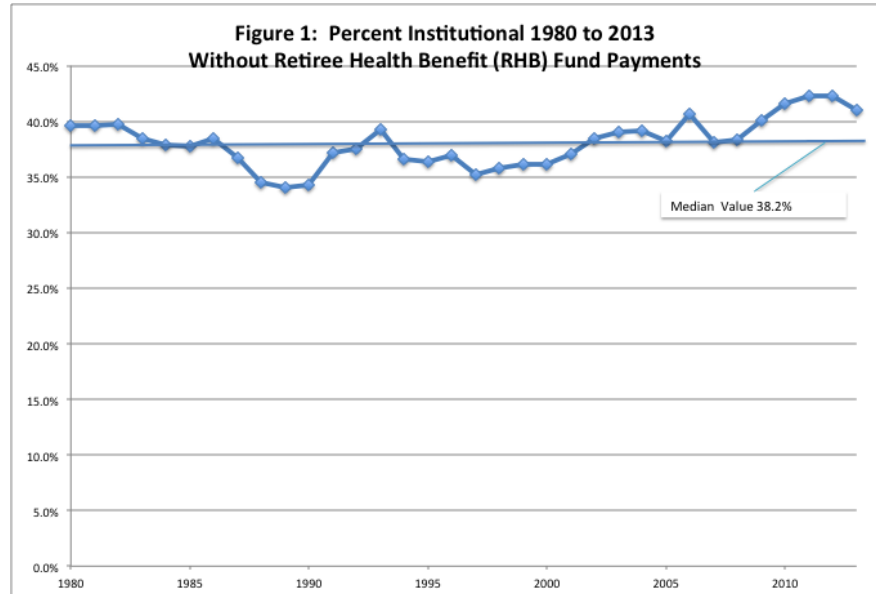**3. Major Postal Developments that have affected the Ratio**

This section will explain why the Postal Services' variability ratio has apparently been so stable over the period 1980 to 2013 even though volume doubled and then declined by more than 25 percent. This stability is illustrated in Figure 1. The ratio deviates from the median line of 37.6 percent by no more than 4.1 percentage points in any year. Many observers have not understood how the

ratio could have remained so stable given the volume fluctuations they witnessed. While volume was growing during this period, the effect of the increase in total volume on total attributable cost was being offset to a large extent by the mix of volume whose average unit attributable cost was declining. See Figure 2. This dampened the increase in attributable cost that otherwise would have occurred with the growth in volume. After the year 2000 when volume growth leveled out, attributable costs began to decline because of the continuing reduction in the unit attributable cost of the volume mix and because of productivity improvements. When volume

began to fall in 2007, the decline in attributable costs accelerated. Since institutional costs have a large fixed component, this resulted in an increasing proportion of institutional costs. How long this trend can be expected to continue will be discussed at the end of this Section.

The influence of mail mix on the ratio

A casual examination of Figure 1 indicates a static ratio. A closer examination will reveal that there are two distinct trends: declining institutional costs from 1980-2000 and increasing institutional costs from 2000-2013. This is more easily observed in Figure 3 (where no adjustment has been made for retiree health benefits.) The double vertical lines bound the beginning of the uptick in institutional costs since, given the imprecision of the data for some years, we cannot be certain in which year the inflection took place.
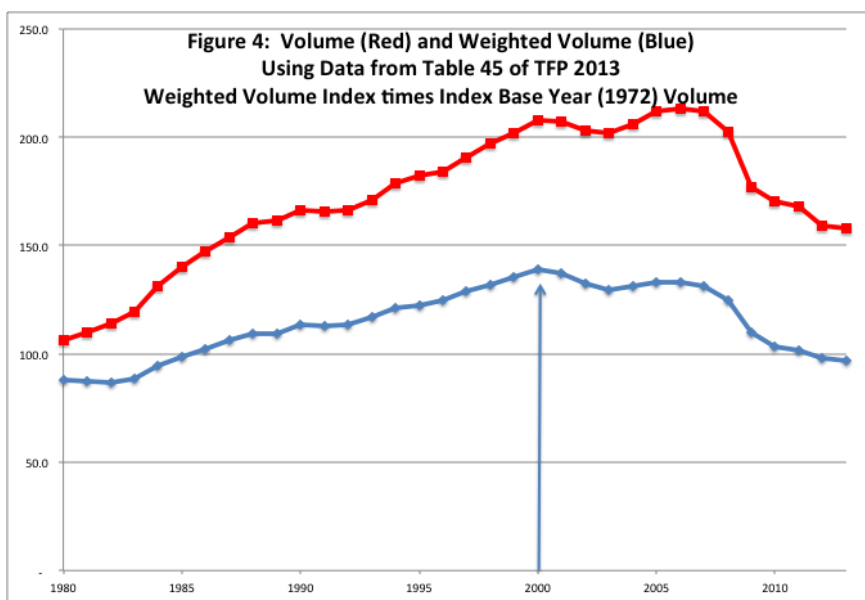

Figure 3: Percent Institutional (Includes RHB)
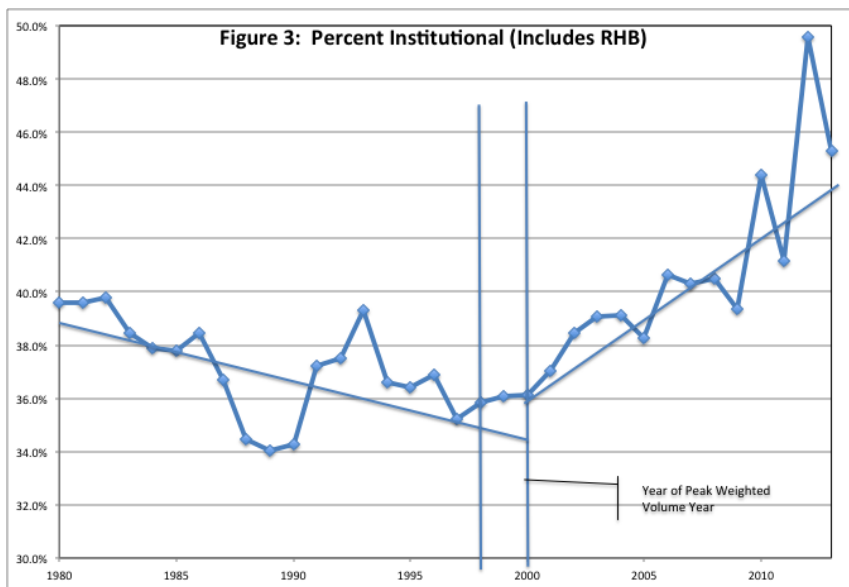
The 20 segments of the Postal Services cost system are partly variable and partly institutional. The ones that are more than half variable will be called "largely variable" and the rest will be called "largely institutional". All things being equal, growth in volume would be expected to increase the largely variable cost segments and decreases in volume would be expected to have the opposite effect. The impact of the doubling of volume from 1980 to 2000 on attributable cost was greatly mitigated by the introduction of worksharing in 1976, which profoundly reduced the work content (or unit attributable cost) of the new volume. Lower prices and other advantages of worksharing led to a huge increase in third class mail (now called Standard mail), which has the lowest work content of all mail

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products.[6] Worksharing also greatly reduced the work content of First Class mail.[7] By 2004, the Postal Service was saving over $14 billion annually from worksharing because it reduced attributable costs by the roughly that amount. Total Postal Service costs were $66 billion in 2004. They would have been about $80 billion with the same volume without worksharing.[8] Thus, worksharing greatly reduced the growth in the attributable cost of the mail stream. This, in turn, reduced the impact of the volume growth on attributable costs.

Weighted volume is of interest because it combines the change in volume and the change in mail mix into a single variable. Figure 4 displays the growth of total volume and the highly correlated growth in weighted volume from 1972 to 2013. In the period before about 2000, the rate of weighted volume growth was much less than the rate of volume growth because of the decline in the average unit attributable cost of the mail mix. Weighted volume apparently peaked in the year 2000 and then declined, as volume growth leveled out in response to increasing use of the Internet, the recession of 2001, the anthrax scare, and 9/11. Both volume and weighted volume

Figure 4: Volume (Red) and Weighted Volume (Blue) Using Data from Table 45 of TFP 2013 Weighted Volume Index times Index Base Year (1972) Volume

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[6] Third class mail volume tripled from 1980 through 2000, far out pacing the 56 percent growth of all other mail categories. Third class was 29 percent of the mail in 1980, but by 2000 it was 44 percent. This was caused by, among other factors, a lowering of the sender's total cost of mailing, an increased ability to target, and the development of a third- party mail industry that had an incentive to sell advertising mail to advertisers.

[7] In 1980 worksharing First Class volume was 11 percent of total First Class letters. By 2000, it was 47 percent.

[8] "Worksharing: how much productive efficiency, at what cost and at what price." Cohen, Robinson, Waller and Xenakis; edited by Crew and Kliendorfer; *Progress Towards Liberalization of the Postal and Delivery Sector*, 2006, Springer.

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turned sharply negative with the great recession of 2007. In 2013, the weighted volume of the Postal Service appears to be about at the level of 1985 when total volume was 140 billion.[9]

1980 to 2000

Figure 5 displays the percentage of total costs that were institutional costs from 1980 to 2000.

The trend line shows that they decreased about 3.5 percent. The corresponding percentage increase in attributable costs is not nearly as much as a doubling of volume might suggest.   The year to year fluctuations around the trend line, including a big dip in the percentage of

Figure 5: Percent Institutional 1980 to 2000

y = -0.0016x + 3.5766
R² = 0.32299
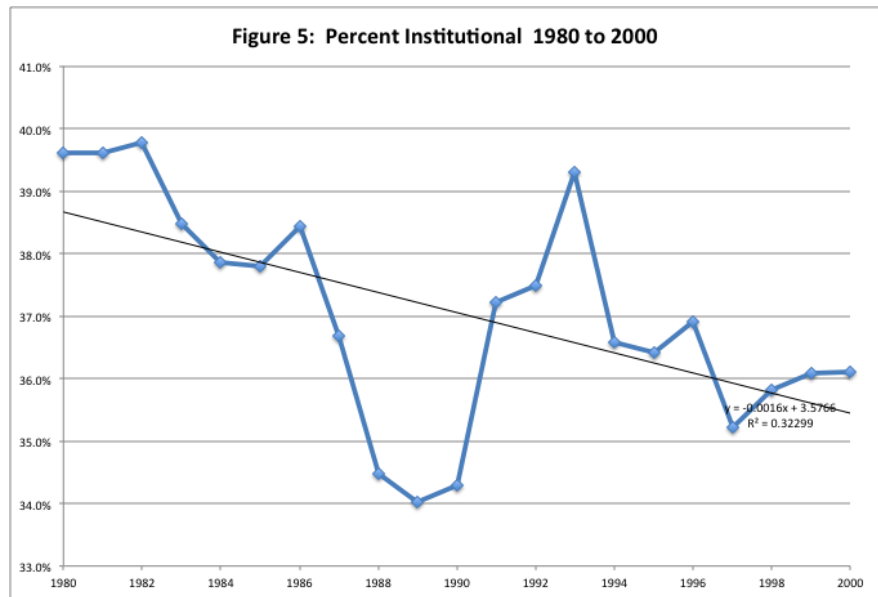
institutional costs between 1986 and 1991, will be examined in Section 5.

2001 to present

After 2000, when total volume began to level off and then decline, First-Class single-piece volume decreased the most. [10]   This had an effect similar to the increase in worksharing in reducing the average unit attributable cost of the mail mix because First-Class single-piece has considerably more work content per piece than presort First-Class or Standard mail. Coincidently, a marked trend of increasing productivity also began in 2000 and which continues to this day. This can be seen in Figure 6. It has served to reduce costs primarily in the largely attributable mail processing and in-office delivery cost segments and associated piggyback cost

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[9] Today the Postal service handles far more parcels than in 1985 and they increase weighted volume more than other products. On the other hand, single- piece First- class was a much larger fraction of Postal volume than now.
[10] First- Class single- piece volume declined from 52 billion pieces in 2000 to 22 billion in 2013, a 57 percent decline, while total volume declined from 208 billion pieces to 158 billion pieces, a 24, percent decline.

segments. Productivity has had much less impact on the largely institutional street delivery

Figure 6: Total Factor Productivity Growth
From ChIR.7.Q.1.TFP.2013.Tables, Tab Out-45
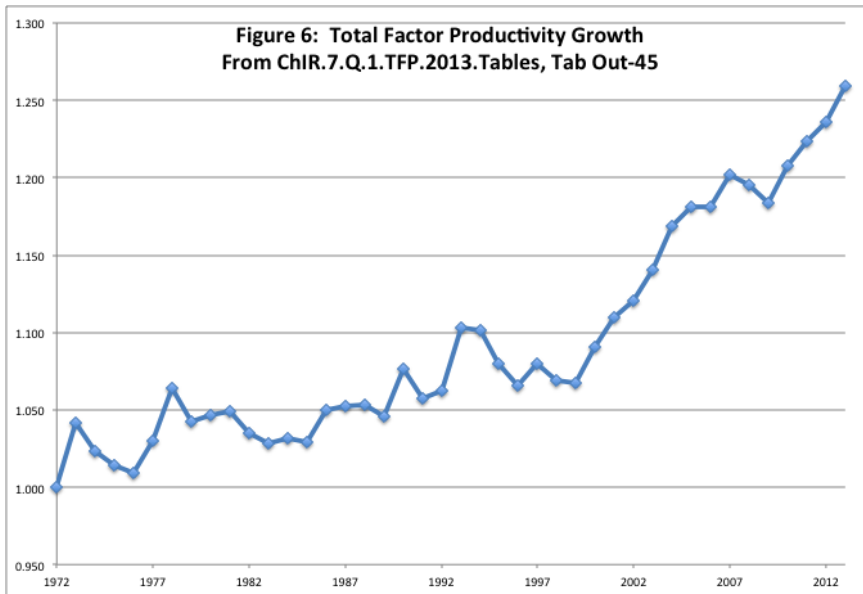
segment. Thus, productivity has, on balance, served to increase the percentage of institutional costs throughout the period. Between 1980 and 2000 productivity growth had been negligible and had little effect on the ratio.[11]

Because volume growth at first flattened and then turned negative after 2000, it no longer offset the impact of the declining average unit attributable cost of the mail. Over this same time, productivity accelerated, which also caused institutional costs to increase as a percentage of total costs. This can be seen in Figure 7 where the trend line is upward sloping.

2007 to 2013

In contrast to market dominant products which have a relatively low unit attributable cost, competitive products have a relatively high unit attributable cost. In recent years, competitive product volumes have expanded. Some products were

Figure 7: Percent Institutional (No RHB)

$y = 0.0035x - 6.7157$
$R^2 = 0.64433$

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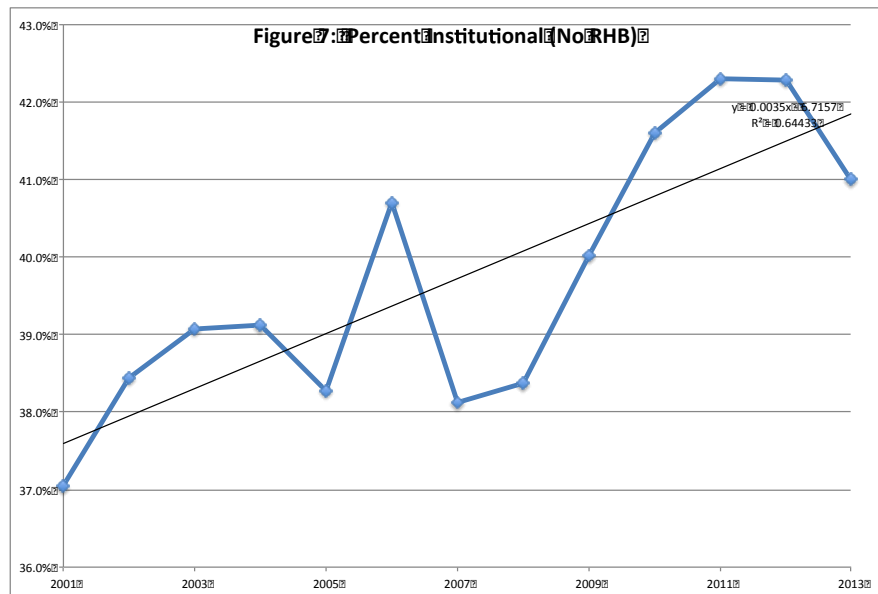
[11] The sudden uptick after years of moribund growth suggests that its cause(s) should be the subject of study.

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transferred from the market dominant to the competitive category. Competitive products have also grown organically at a substantial rate.[12] Organic growth of pieces with a relatively high level of attributable costs increases the attributable/institutional cost ratio, while the volume loss of market dominant products decreases it. This is somewhat like the two regimes observed prior to, and after, 2000, as seen in Figure 2. The current decline in attributable costs of the market dominant products, and of the attributable costs of the Postal Service as a whole, resembles the post-2000 period. The growth of the total attributable cost of the competitive products, on the other hand, resembles the pre-2000 period. Currently, competitive products account for about a quarter of total Postal Service attributable costs. As market dominant volumes continue to drop and competitive organic volumes continue to grow, the two may have largely offsetting effects on the Postal Service variability ratio. But for now, the variables that negatively affect weighted volume (declining volume, declining attributable-cost volume mix, and increasing productivity) are likely to remain in place for the foreseeable future. Thus, the ratio can be expected to continue in its current direction of an increasing percentage of institutional to total costs.

It will be seen in the Section 4 that the percentage of total costs that are institutional has increased monotonically since 2008. However, this has been a period of improving finances for the Postal Service on an operational basis. The reason is that increasing revenues from competitive products have more than offset the revenue losses from market dominant products. There is a large difference between the average unit revenue of the two groups of products. This has altered the traditional significance of the variability ratio, which only reflects costs.

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[12] By organic growth we mean growth of the products that have been previously designated competitive before new products were switched from market dominant to competitive.

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4. The Impact of Exogenous Events on the Ratio

1980-2006

There have been many exogenous events that have affected the ratio since 1980. They include: the Congressional Omnibus Budget Reconciliation Acts (OBRA), restructuring costs, recalculating workers compensation liabilities, the PAEA mandate to escrow payments for future retiree health benefits (RHB), and accounting rule changes.

With the assistance of PRC staff we examined the Postal Service financial statements since 1980 to find the charges made to the income statement that would affect the ratio.[13] Charges that were for prior years affected only institutional costs. These were

Table 1
Charges to the Income Statement That Affected Institutional Costs (1980-2013)

Year	Amount ($billion)	Percent of Total Cost for Year	Reason
1980	.268	1.4	Workers Compensation Adjustment
1981	.702	3.3	Workers Compensation Adjustment
1982	.286	1.2	Workers Compensation Adjustment
1991	2.1	4.6	OBRA
1992	1.0	2.1	Restructuring Costs
1993	1.5	3.0	OBRA, Refinancing of Debt and Restructuring costs
1997	.26	0.3	Workers Compensation Adjustment
2009	1.343	0.2	Workers Compensation Adjustment
2010	2,441	0.3	Workers Compensation Adjustment
2011	2,410	0.3	Workers Compensation Adjustment
2012	2.377	0.3	Workers Compensation Adjustment
2013	-290	negligible	Workers Compensation Adjustment

examined to see their effect on the ratio. They are displayed in Table 1. The OBRA adjustments required the Postal Service to pay prior year costs for Retiree Health Benefits and pension COLAs.[14]

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[13]Charges that failed to materially affect the ratio were ignored.
[14] The legislation required increases in the CSRS liability based on the annuitant COLA's including interest and the premiums for RHB to be paid by the Postal Service from then on. They were a recurring cost from 1989 through 2003. The retiree health benefits premiums continue to be paid by the Postal Service today. These costs vary with all labor and thus do not affect the attributable/institutional ratio.

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Restructuring costs were primarily for early retirement bonuses. Debt refinancing charges were caused by the Postal Service refinancing its debt with the Treasury Refinance Bank. Workers compensation adjustments were caused by using new discount rates to calculate the present value of the liability and/or to update expected medical and compensation cost inflation. These were done on an occasional basis prior to 2008. The Postal Service has been making annual adjustments to the workers comp long-term liability since FY 2009 because of a change to an accounting rule.

Figure 8 displays the impact of the workers compensation adjustments in 1980, 1981, and 1982, and the OBRA adjustments in 1991 and 1993. The two sets of adjustments are the largest exogenous adjustment in the period before the year 2000. Red represents the data as given in the annual CRAs. Blue represents what the data would have looked like if the exogenous adjustments had not been made.

Figure 8: Percent Inst with (Red) and without (Blue) WC Adjustments and OBRA Exogenouse Effects

$y = -0.0016x + 3.5766$
$R^2 = 0.32299$

$y = -0.0015x + 3.3285$
$R^2 = 0.29821$
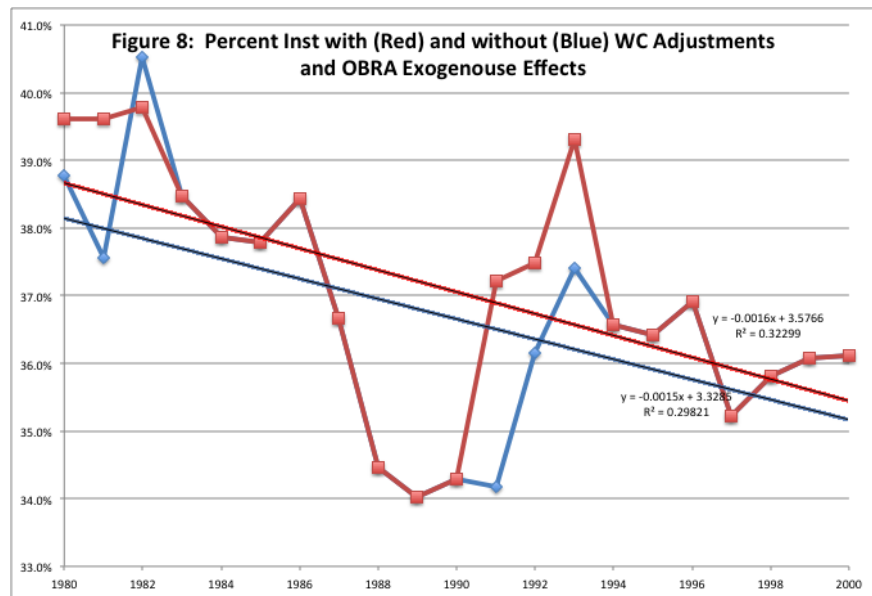
2006-2013

The most significant exogenous effect on the ratio of attributable and institutional costs from 2006 to 2013 has been the Congressionally-mandated Retiree Health Benefit Fund included in the PAEA. The Service was scheduled to pay about $5 billion annually into this fund. Subsequent actions by the Congress have altered the amount in the prior fiscal years. For example, the FY 2011 RHB was shifted to 2012 by an Act of Congress. These actions led to the saw tooth institutional percentage exhibited by the blue line in Figure 9. Subtracting

the RHB effect, which is predominantly institutional, is shown by the red line. The trend line is still positive but with a lower slope than when RHB costs is included. For this reason, in all subsequent analysis, the RHB payments are subtracted from both the institutional and total accrued costs in the CRA. The green line is percent institutional without RHB and without Workers Compensation Prior Year Liability Adjustments. The trend lines in both Figure 8 and 9 show that the impact of the exogenous changes do not affect the direction of the longer term trends.

5. The Impact of Changes in Costing Methodology on the Ratio

Figure 9: Percent Inst. With RHB and WC Prior Year Adj (Blue), Without RHB but With WC Prior Year Adj (Red), and Without RHB & WC Prior Year Adj (Green)
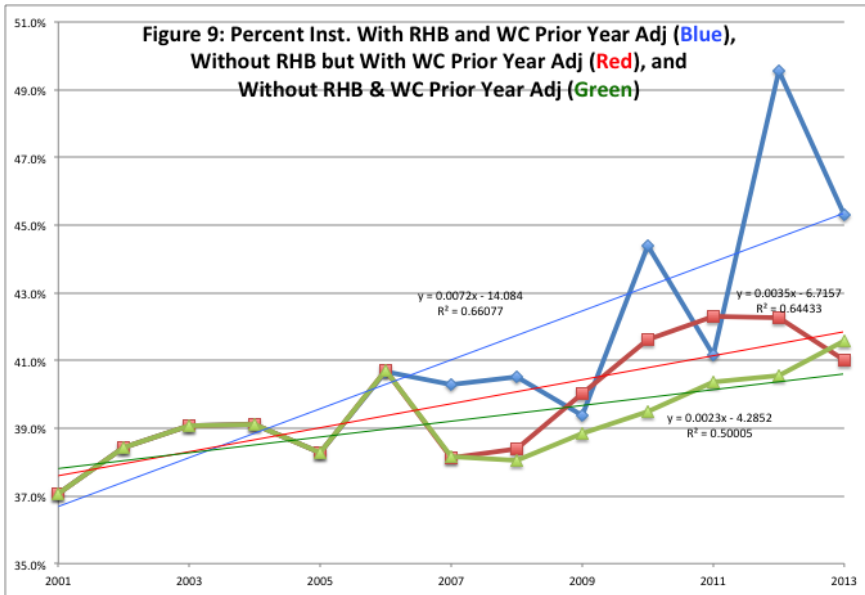
The cost methodology that underlies each segment and component of the Postal Service CRA generally generates stable results from year to year. However, when a change does occur, it can alter the ratio of attributable and institutional costs for many years.
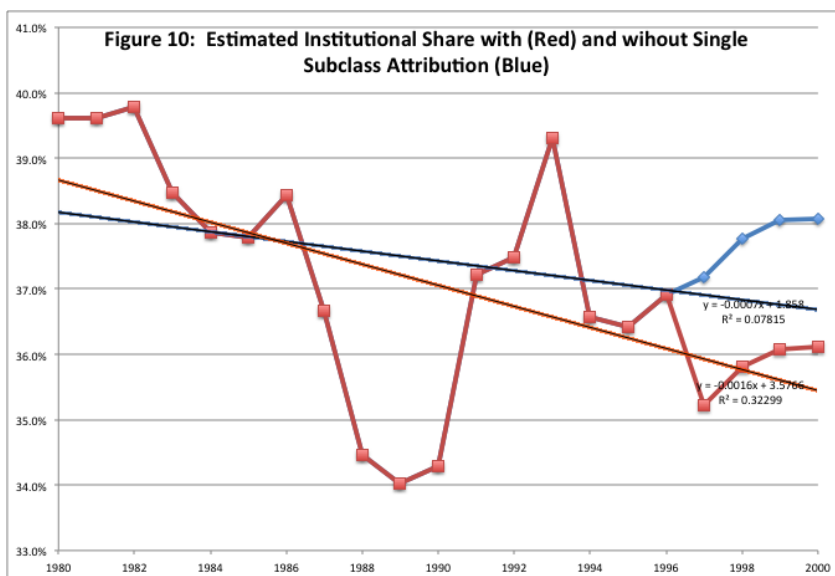
Some of the methodological changes affect only the distribution of costs to products, and have little if any effect on the ratio of institutional to attributable costs except, possibly, by altering the mail mix. Since 1998 these changes were adjudicated in rate and mail classification dockets. Since the adoption of new rules for changing cost methodologies in response to the PAEA, the methodology adjustments occur in rulemakings to change "Analytical Principles", commonly called "car washes." Over time, the methodological changes for calculating attributable costs in some cost segments have had small effects on the ratio of attributable and institutional costs (i.e., vehicle service drivers and purchased transportation). They

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make up 0.8 and 2.4 percent of total accrued FY 2013 costs, which is quite small compared such major cost segments as Clerks (19.0 percent) and City Carriers (16.7 percent).

Adopting a new data source for analysis in 1989 increased Vehicle Service Drivers attributable costs from 16.0 percent to 47.3 percent. This contributed to a 0.5 percent increase in total attributable cost or, conversely, to a 0.5 percent drop in total institutional cost. The graph of percent institutional costs in Figure 8 drops to its lowest point 1989.

The Single Subclass method for attributing City Delivery Carrier Costs was instituted by the Commission in 1987 and abandoned in 2005. A new City Carrier methodology was proposed in Docket R-2005-1 and adopted by the Commission that did not use Single Subclass attribution methods. Mail Processing attributable cost methods, which yield variabilities of nearly 100 percent, have changed little over the years. In Docket R97-1, the Postal Service proposed a new analysis of Mail Processing costs that resulted in an approximate 82 percent variability. The Commission did not adopt the proposed change, but the Postal Service continued to use the methodology in its cost estimates until 2006. A comparison of the Commission's and Postal Service's cost estimates during the post 97 era provides a good indication of the impact that such an important methodology change would have had on the ratio of attributable and institutional cost. The actual impact of the City Carrier methodology changes, and the potential impact of the proposed Mail Processing methodology changes are examples of how major changes can impact the attributable and institutional share of costs and helps explain

Figure 10: Estimated Institutional Share with (Red) and wihout Single Subclass Attribution (Blue)

the 1997 dip in the percent institutional in Figure 10.

City Carrier: Impact of Single Subclass Methodology

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The Single Subclass methodology was adopted by the PRC in Docket R87-1. The data available for this study-- Postal Service Costs from 1980 to 2013 and PRC costs from 1997 to 2013-- provides a mechanism for exhibiting the impact of the Single Subclass methodology by examining the shift in the share of institutional cost between 1996 using Postal Service costs and 1997 using PRC costs. For example, the share of institutional costs calculated by the Postal Service (without Single Subclass attributable costs) for 1996 is 36.9 percent. The share of institutional costs calculated by the PRC for 1997 (with Single Subclass attributable costs) is 35.2 percent. The total difference of 1.7 percentage points in institutional share is not entirely due to the Single Subclass methodology since volumes are changing. But it is a good proxy. Adding the 1.7 percent to the institutional costs calculated by the PRC for 1997 to 2000, provides an indication of what the costs would have been without the Single Subclass methodology after 1997. Figure 10 displays the effect of the change from 1997 to 2000. It can be seen that the slope of the trend line does not change our findings about the downward slope of the trend. Institutional costs decreased (and attributable costs increased) by a modest amount.

Of course, it would have been better to have actual costs calculated with the USPS methodology without Single Subclass attribution for the period after 1997. The problem is that in 1997, the Postal Service began using its mail processing cost methodology in all cost calculations and the impact swamped the effect of the Single Subclass methodology.

Distinguishing the Impact of Applying Single Subclass Attribution Methods from the Impact of Applying the Postal Service's Proposed Mail Processing Attribution Methods

An analysis of FY 1997 segment costs using the PRC and Postal Service cost methodologies can separately identify the potential impact of applying the Postal Service's proposed mail processing attribution methods. Had the PRC adopted the Postal Service's proposed methodology for attributing mail processing costs in Docket R-97-1 and had the Postal Service adopted the Commission's Single Subclass attribution method, the ratio of institutional to attributable cost would have been much different. Table 2 compares of the total institutional share that using the Postal Service's proposed attribution methods would yield s (with 82 percent Mail Processing variability and no Single Subclass attribution method) with the total institutional cost share that using the PRC's attribution methods would yield (with almost 100 percent Mail Processing variability and the Single Subclass method). The Postal Service's method estimates Mail Processing Variability at 82 percent, which increases the percent of institutional costs, and the PRC's methods apply the Singles Subclass attribution methodology, which

increases the attributable costs and reduces intuitional costs. The difference calculated reflects both the increase in institutional costs using Postal Service methods and decrease when using the PRC's methods.

Table 2
Comparison of Percent Instutional of PRC (100% Variable Mail Processing & Single Subclass Attributiona) and USPS (82% Variable Mail Processing

	1997	1998	1999	2000	2001	2002	2003	2004	2005
USPS	43.5%	43.8%	40.3%	41.9%	43.2%	43.1%	43.3%	43.6%	42.3%
PRC	35.2%	35.8%	36.1%	36.1%	37.0%	38.4%	39.1%	39.1%	38.3%
Difference	8.3%	8.0%	4.2%	5.8%	6.1%	4.6%	4.3%	4.5%	4.0%

To analyze the impact of the difference in 1997, the PRC staff was able to provide a spreadsheet comparing the attributable and institutional costs for FY 97 using the PRC's methods (Single Subclass attribution and 100 percent Mail Processing variability) and the Postal Service's proposed methods (no Single Subclass attribution and 82 percent Mail Processing variability.) Applying the Singles Subclass attribution primarily affects Segment 7. Other segments are impacted by piggybacking Segment 7 variabilities (Segments 12, 13, and part of 20.) Similarly, applying the 82 percent Mail Processing variability method primarily impacts Segments 3, with Segments 11, 15 and 16 impacted through piggybacking Segment 3 variabilities.

The differences in total institutional costs that result from using Postal Service versus PRC costing are given in Table 3. As can be seen in Table 3, of the 8.3 percent difference, 5.2 percent comes from applying the PRC's Mail Processing variability assumptions, 1.7 percent is due to applying its Single Subclass attribution methods, and 1.4 percent is due to other impacts.

The Big Dip in Percent of Institutional Costs from 1987 to 1992
The above discussion does not explain the significant dip in the institutional cost percentage between 1987 and 1992. The data available for this time period are cost estimates applying the Postal Service's proposed attribution methods and so does not reflect Single Subclass attribution methods. Applying Single Subclass methods would cause a dip in institutional cost percentages. A review of adjusted costs by segment identifies a big shift of City Carrier costs from institutional to attributable from 1987 to 1992. Before and after this period, the City Carrier percent attributable is in the low 50's. During this period, however, the percent attributable is generally in the high 50's, reaching 61.1 percent in 1988. The percentage of institutional cost is at its second lowest in 1988, and at its lowest in 1989, when the
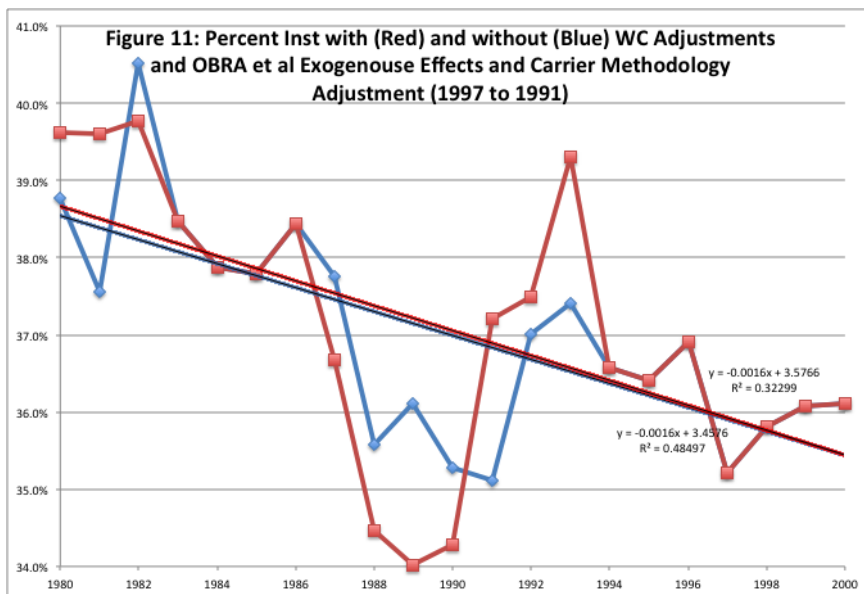
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Table 3

Methodology Differences in Institutional Costs (PRC costs minus USPS costs)

	Total	Mail Proc	Carrier	Other Seg.
1. Postmaster	-			-
2. Total Supervisors	(258,122)			(258,122)
3. Total Clerks	(2,624,387)	(2,624,387)		
4. Clerks, Third-class Offices	-			-
6. In-Office	1			1
7. Total City Carriers	(533,565)		(533,565)	
8. Vehicle Service Drivers	3,265			3,265
9. Total Sp Del Messengers	(49,565)			(49,565)
10. Total Rural Carriers	-			-
11. Custodial (maint.) Service	(145,500)	(145,500)		
12. Motor Vehicle	(123,676)		(123,676)	
13.Misc. Operating Expenses	(357)		(357)	
14. Total Transportation	(185,929)			(185,929)
15. Total Building Occupancy	(13,100)			(13,100)
16. Supplies and Service	(217,542)	(217,542)		
17 & 19 Research, Develop. & HQ	-			-
18. Headquarters	(292,569)			(292,569)
19. Support Services				-
20. Total Deprec./Ser Wide Costs	(286,878)		(286,878)	
Total Inst Cost Differences	(4,727,924)	(2,987,429)	(944,476)	(796,019)
Percent by Column	100.0%	63.2%	20.0%	16.8%
Components of Percentage Diff	8.28%	5.24%	1.66%	1.39%

new Vehicle Service Driver methodology increased attributable costs by another half percent at the bottom of the blip. From 1986 to 1987, the City Carrier attributable percent rose from 51.6 percent to 57.2, precipitating the observed downward blip in the institutional percent of total costs. The slump in total institutional percent abruptly ends in 1992 when the City Carrier percent attributable falls back towards the low 50's value. Table 4 presents the actual attributable percentages for City Carrier costs and total costs for 1986 to 1993, as well as total percent institutional.

Table 4: Carrier Cost Methodology Impact

Year	1986	1987	1988	1989	1990	1991	1992	1993
Carrier Attributable	51.6%	57.2%	61.6%	58.9%	58.5%	57.7%	56.6%	52.3%
Total Attributable	61.6%	63.3%	65.5%	66.0%	65.7%	62.8%	62.5%	60.7%
Total Institutional	38.4%	36.7%	34.5%	34.0%	34.3%	37.2%	37.5%	39.3%

A portion of the dip in the share of total institutional costs could be due to changes in mail mix. But the increase is so large and so sudden in City Carrier attribution percentages that the drop in percent institutional costs appears to be the result of a change of methodology by the Postal Service. Research into the nature of the City Carrier attribution methodology changes between 1987 and 1992 found that starting in 1987, the Postal Service increased the amount of Elemental Load activity costs by more than $300 million. This increase ripples through the other cost segments, producing a total increase in City Carrier-related attributable costs t of over $400 million. Because elemental load costs are 100 percent variable, total attributable costs are increased by the $400 million transferred to elemental load. Total institutional costs are decreased by the same amount. In Figure 11, a $400 addition to institutional costs as a percent of total accrued costs for 1987 to 1992 has been added to the institutional costs calculated by the Postal Service to demonstrate the impact of this increase in elemental load costs on percent of total costs that are institutional. This addition removes a significant portion of the dip in the institutional percent.

Figure 11: Percent Inst with (Red) and without (Blue) WC Adjustments and OBRA et al Exogenouse Effects and Carrier Methodology Adjustment (1997 to 1991)

Segment 18, Total Administrative and Regional Offices, also contributed to the overall dip in the institutional percentage with an unexplained drop in institutional Segment 18 expenses in 1987 from 56.6 to 48.9 percent of total costs. This impact of the Segment 18 changes, if added to the institutional costs that result from applying Postal Service costing methods, would lift the blue curve in Figure 10 even more, but would still maintain its overall downward trend. Accounting for the impact of changes in attribution methods over the period 1987 to 1992 does not change our finding that the attribution percentage of total costs fell from 1980 to 2000 and rose from 2001 to 2013.

Summary of Sections 2 to 5

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We have explained that over the period from 1980 to 2013 the variability ratio has been primarily influenced first by increasing volume and then declining volume and a decline in the unit attributable cost of the that volume due to the effects of worksharing, the growth of Standard Mail, and then the decline of First Class mail. The post- 2000 growth in institutional cost percentage has gone hand in hand with deteriorating finances of the Postal Service. This trend may be arrested by the growth of competitive- product volume. We have also shown that neither endogenous changes (e.g., workers compensation adjustments and OBRA expenses) nor methodological changes (e.g. single subclass stops and elemental load changes) have changed the basic slope of the variability ratio for the two distinct periods when weighted volume was growing and then declining (i.e., pre-2000 and post-2000.)

6. Infra-marginal and Fixed Cost Trends 2007 to 2013

In the Report on Task One of this series, Professor Panzar defines and discusses the concept of infra-marginal costs. As he notes "Infra-marginal costs are not a standard economic cost concept. Essentially, they are defined by what they are not: i.e., they are variable costs that are not volume variable (marginal) costs.[15]"

Report 2 provides the first calculation of infra-marginal and fixed costs for the fiscal years 2007 to 2013. The analysis is with the Retiree Health Benefit (FHB) and Workers Compensation costs removed, since they are not under the direct control of the Postal Service. The intent of the analysis is to see how operating costs within the Postal Service's control are behaving. [16]

The volume of mail for this period was monotonically decreasing from 212 billion pieces in 2007 to

Figure 12: Costs in Nominal Dollars vs Volume (right hand axis)

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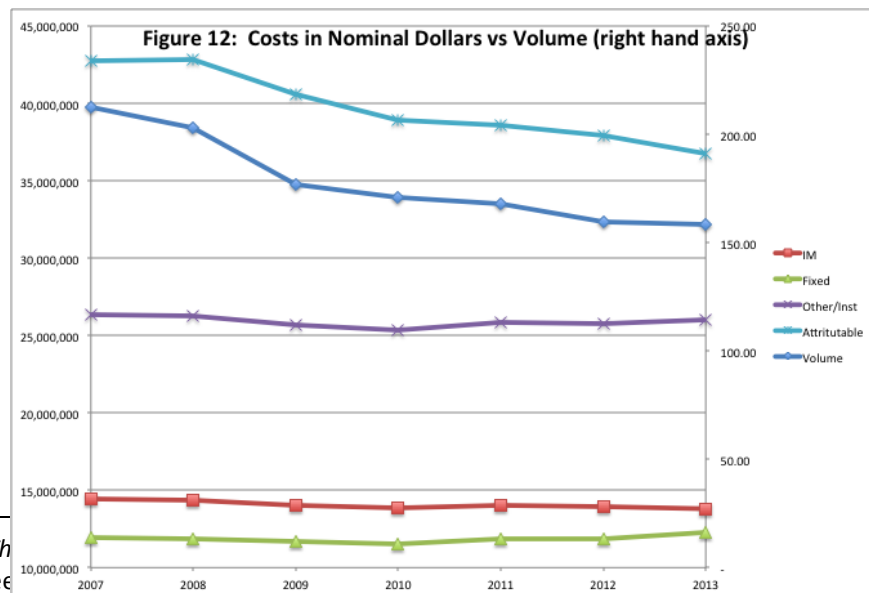
[15] See page 11 of Report 1 *Th[...]* mathematical definition. See [...]
[16] Report 2 analyses remove all Workers Compensation, which is reflected in the analysis in this section. The analysis in the other parts of Report 3 removes only prior year adjustments of Worker Compensation payments. The difference in terms of percent of institutional costs is less than 0.09 percentage points.

158 billion in 2013. Figure 12 portrays the attributable, infra-marginal and fixed nominal costs versus volume for these years, as calculated in Case 2 of Report 2. As expected, the attributable costs drop monotonically. However, fixed costs rise slightly in 2011 and 2013 and infra-marginal costs rise in 2011. This demonstrated that attributable and infra-marginal do not move in the same direction in all years and fixed costs can change too. But much of this effect is removed when costs are plotted in real dollars as in Figure 13.

The percentage declines observed over this seven-year period are quite dramatic when examined in real 2007 dollars as shown in Table 5. The drop even in fixed costs is a reflection of the dramatic

Table 5: Percent Change From 2007 to 2013 in Real 2007 Dollars

Volume	IM	Fixed	Other/Inst	Attritutable	All Variable	Total
-25.4%	-15.4%	-9.4%	-12.7%	-24.1%	-21.9%	-19.7%

increases in productivity and cost cutting activities of the Postal Service during this post PAEA period. See Figure 6 above.

Figure 13: Costs in 2007 Dollars versus Volume (right hand axis)
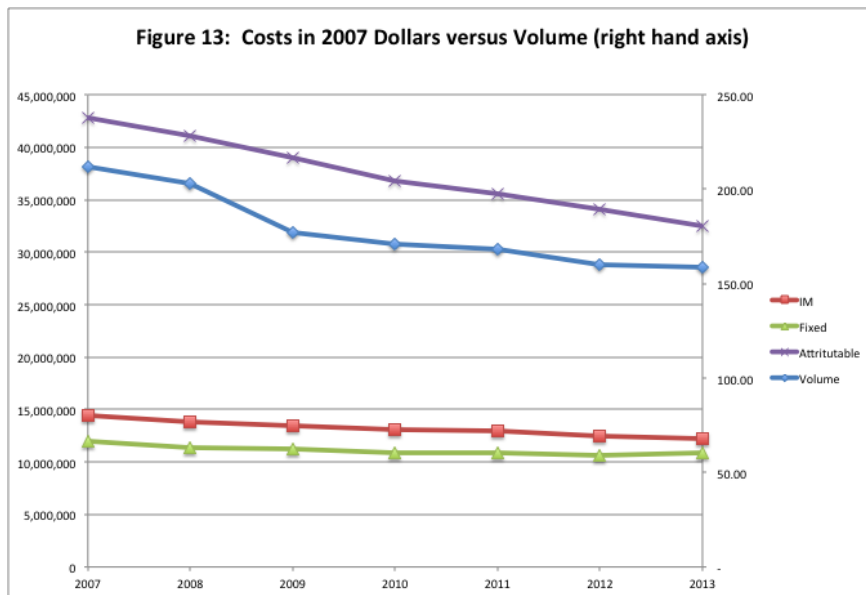
Like many of the deviations from static patterns in the variability ratio pre 2007 period, the increases in fixed costs in 2011 and 2013 can be traced to some one-time events. In this case, however, the events are not exogenous to the system, but are of the Postal Service's making. This deviation in fixed costs can be traced for the most part to an unusually large increase in Segment 18 Administrative and Area Operations costs.   See Table 6.

Further examination of the components of Segment 18 reveals that the component "Individual Awards", which are nearly all fixed costs, is the major source of the increase.   In 2010 the individual awards costs were $5.9 million versus in 2011 they were $396.2.   Also, Segment 16 fixed costs increased by $111 million between 2010 and 2011. This increase was due overwhelmingly to two cost components-- "ADP

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Supplies and Services" and "Product Specific Supplies and Services. The reason for this increase in supplies and services is unknown, but may reflect a management decision to replenish after a period of financially- enforced frugality.

The 2013 increases in fixed costs can also be traced to personnel actions. There was a spike of $166.6 in Segment 13, Employee Awards, and in Segment 18 $36.5 million in "Individual Awards" and $215.3 million in "Miscellaneous Personnel Compensation." These observations are not a criticism of these personnel rewards. They merely point out that dramatically changing the amount awarded in a given year can cause fixed costs to deviate from an overall trend. There may be an incentive to defer awards in difficult financial years, and then to meet the deferred demand in a catch-up year to maintain employee relations.

Table 6: Difference in Fixed Costs Year to Year in Nominal Dollars

		2008	2009	2010	2011	2012	2013
Seg 1	C/S 1 Postmasters	310	5,382	-1,162	-1,006	4,182	-5,439
Seg 2	C/S 2 Supervisors & Technicians	26,247	-91,927	-56,574	-37,898	-51,581	-16,771
Seg 3	C/S 3 Clerks & Mailhandlers CAG A-J	-12,998	-27,417	-32,071	-11,638	-101	-812
Seg 4	C/S 4 Clerks CAG K	0	0	0	0	0	0
Seg 6	C/S 6 City Delivery Carriers Office	-82,527	-183,574	-63,894	-31,087	-2,181	12,539
Seg 7	C/S 7 City Delivery Carriers Street	-7,887	11,841	6,728	38,715	39,762	-8,794
Seg 8	C/S 8 Vehicle Service Drivers	0	0	0	0	0	0
Seg 10	C/S 10 Rural Carriers	177,126	113,589	107,540	90,356	136,737	98,382
Seg 11	C/S 11 Custodial & Maint Services	0	0	0	0	0	0
Seg 12	C/S 12 Motor Vehicle Service	87,115	-72,116	25,557	81,163	13,679	36,307
Seg 13	C/S 13 Misc Local Operations	-239,781	-83,448	67,265	11,967	-43,183	154,560
Seg 14	C/S 14 Transportation	2,288	24,525	-8,417	14,065	-1,458	8,618
Seg 15	C/S 15 Building Occupancy	-24,680	13,480	-41,510	-23,377	-13,779	-6,505
Seg 16	C/S 16 Supplies & Services	47,606	-27,389	-80,913	110,967	-12,985	50,067
Seg 17	C/S 17 Research & Development	-1,708	-2,989	-2,721	2,027	2,107	4,451
Seg 18	Adj C/S 18 Admin & Area Ops (no WC/RHB)	-60,781	137,102	-99,630	307,686	-308,011	176,844
Seg 19	C/S 19 General Management Systems	6,047	-15,684	14,741	5,820	-10,172	-5,296
Seg 20	C/S 20 Other Servicewide Expenses	7,771	36,591	-45,121	-16,726	27,690	-81,594
	Total Change in Fixed Cost over SPLY	-75,851	-162,035	-210,181	333,462	-11,720	416,557

Understanding the reason for the infra-marginal cost changes moving in a different direction from volume is a bit subtler. In all years but 2011, total attributable and infra-marginal cost changes dropped as volume dropped. But in 2011, infra-marginal costs increased while volume continued to drop.

The source of the 2011 anomaly is a combination of trends in Segment 3 (Mail Processing Labor) and in Segment 7 (City Delivery Carrier Labor) attributable and infra-marginal costs, particularly in the Segment 7 components "Delivery Activities" and "Support Activities." Segment 7 attributable and infra-marginal costs increased in all years (except for infra-marginal costs in 2013). Prior to 2011, the decreases in Segment 3 infra-marginal costs offset the Segment 7 infra-marginal cost increases.   But Segment 3 Mail

Processing attributable and infra-marginal costs were decreasing each year to the point that in 2011 they could no longer offset the Segment 7 City Carrier increases. After 2011, decreases in infra-marginal costs in other segments combined to offset the impact of the increase in Segment 7 infra-marginal costs.

Within Segment 7, the components "Delivery Activities" and "Support Activities" represent around 86 percent of the total City Carrier Street Time Cost. The constant elasticity method is used to calculate attributable and infra-marginal costs of those components. One might expect, ceteris paribus, that these attributable and infra-marginal costs would increase and decrease together as volume changes, since attributable and infra-marginal costs are proportional for components whose infra-marginal costs are assumed to have constant cost elasticity.[17] These cost types do move together in the same direction, but they move in the opposite direction of volume (except for infra-marginal costs in 2013). As shown in Table 7, attributable costs for the Delivery Activities cost increase every year in nominal dollars despite a volume drop. Infra-marginal costs also increase for every year except 2013.

Table 7: Annual Differences in Delivery Activities Infra-marginal and Attributal Costs in Nominal and 2007 Dollars

	2008	2009	2010	2011	2012	2013
SPLY Difference Deliver Activities Infra-marginal Nominal $	18,547	46,405	50,388	127,992	126,672	2,085
SPLY Difference Deliver Activities Attributable Nominal $	26,091	59,502	71,619	163,684	141,614	-35,505
SPLY Difference Delivery Activities Attributable 2007 $	-136,543	55,924	-11,163	26,393	29,808	-55,704
SPLY Difference Delivery Activities infra-marginal 2007 $	-179,591	72,205	-10,244	29,358	15,900	-107,284

But in real 2007 dollars, the increase in infra-marginal costs is split between increases in three years and decreases in three years.

The cause of the increase in nominal attributable and infra-marginal costs for Segment 7 City Carrier Delivery Activities and Support Activities is due to economies of scale lost in these postal operations. In 2013, the economies of scale in delivery appear to be recaptured, possibly due to management efficiency improvements. Two factors that may cause these increases in attributable and infra-marginal costs are: an increase in the more expensive to deliver competitive products, especially parcels requiring retrace, a drop in overall pieces per delivery. It should be noted that a drop in the percent of addresses receiving mail on routes, called coverage, could actually reduce fixed and infra-marginal costs in the current environment of declining pieces per delivery. Researching these and other possible causes is beyond the scope of this project.

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[17] See Report 2 Section 2.3. Constant Elasticity Cost Function. The proportionality does not extend beyond the component or subcomponent level at which the costs are calculated with a constant elasticity function as the costs are aggregated across components and subcomponents. The mail mix and various elasticities affect the relationship between the cost types. See Report 2, following Table 5 for a discussion of this effect.

The value in finding a deviation from expected changes in fixed or infra-marginal costs is that it indicates an unusual cost being incurred possibly due to management decisions concerning personnel payments, changes in operating plans, or changes in mail mix resulting in a greater share of pieces that are more costly to handle.

7. **Implications of Infra-marginal Cost Calculations on Average Unit Cost**

The impact of changes in cost calculations is often judged in terms of the impact on average unit cost. For instance average unit cost was the primary measure of impact in the last major study of the quality of Postal Service data systems.[18]   Frequently, all institutional costs are assumed fixed in calculating future average unit costs as volume changes. However as just discussed, fixed costs are estimated to be less than one half of institutional costs. This estimate is likely to improve over time as data limitations identified in Report 2 are addressed.

This section uses an illustrative example to indicate the impact of different estimates of fixed cost on average unit cost as volume changes. For most small changes in volume, the impact is minimal, but it can be large when the declines in volume are as great as those currently being experienced.

When economies of scale are present, average cost per unit decreases as volume, Q, increases. Conversely, as volume drops, unit costs will increase.   This condition is characterized by a volume variability factor, or elasticity, that is less than one. Volume variable costs at volume Q equal total cost at Q times marginal cost.

Two factors drive the changes in unit costs as volume changes: the magnitude of fixed costs and the elasticity of variable costs.[19] And the results will be different depending on the magnitude of fixed costs. Institutional costs are frequently treated as fixed in the estimation of future costs.   Report 2, however, calculates fixed costs that are considerably less than institutional costs. The following discussion of the

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[18] See A.T. Kearney, Inc., *Data Quality Study* (Alexandria, VA April 16, 1999) performed under contract with the Postal Service in response to a request from the Congressional Committee on Government Reform and Oversight.
[19] This assumes that costs can be represented as a fixed cost plus variable costs. Note that elasticity of variable costs and elasticity of total costs are two different things. See Report 1. Elasticity of total costs equal marginal costs divided by total average unit costs, which involves the fixed cost element. The elasticity of the variable portion of a function does not involve the fixed cost element.   The value of the distinction is in creating an illustrative example to show the different effect of fixed and variable component which is affected by the elasticity of the variable component.

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difference in unit costs of two postal systems with different volumes but similar cost functions is based on an illustrative example developed by Professor Panzar. For convenience of discussion we will treat the difference in the Postal Service's operations at two different volume levels as the two different postal operators in Panzar's initial formulation. Let i = 1,2 where i =1 is the Postal Service at 2013 volumes Q_1 and i =2 is the Postal Service at a smaller volume Q_2. Focusing on the effects of volume, Q, on per unit costs, AC, assume the Postal Service at both volume levels has the same *cost function*, $C(Q)$. For exposition purposes, assume that the costs of the postal operator are given by the function

$$C(Q_i) = F + zQ_i^e,$$

where e is the elasticity of variable costs, F are fixed costs and z is a constant chosen to fit the costs[20]. Finally, assume that the volumes are a multiple $x < 1$ of each other so that $Q_2 = xQ_1$.

This cost function has two sources of economies of scale, each of which may be working *without* the other. That is, there may be substantial economies of scale if fixed costs are large, even if e = 1. Similarly, if $e \ll 1$, there may be substantial economies of scale even if fixed costs are small (or even zero).

Letting AC = average costs gives

$$AC_1 = \frac{C}{Q_1} = [F + zQ_1^e]/Q1 = \frac{F}{Q_1} + zQ_1^{e-1} \text{ by substitution and similarly}$$

$$AC_2 = \frac{F}{Q_2} + zQ_2^{e-1} = \frac{F}{xQ_1} + zx^{e-1}Q_1^{e-1} \text{ since } Q_2 = xQ_1$$

and subtracting the two gives

$$AC_1 - AC_2 = \frac{F}{Q_1}\left[1 - \frac{1}{x}\right] + zQ_1^{e-1}[1 - x^{e-1}] \text{ by substitution and combining terms in [ ].}$$

The unit cost difference between a "large" and "small" post depends upon *both* the magnitude of fixed costs *and* the elasticity of variable costs.

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[20] Throughout the following example, e does not represent total cost elasticity. It is only the elasticity of the variable portion of the cost function. This is consistent with Professor's Panzar's presentation in his report on Task 1. See page 26, equations (27) and (28).

Also, let Institutional Costs = I, Volume Variable Costs = VV, Marginal Cost = MC, and Fixed Cost = F.[21]

Then for this cost function formulation

$MC = ezQ^{e-1}$ the first derivative of C with respect to Q,

$VV = Q * MC = Q * ezQ^{e-1} = ezQ^e$

$I = C - VV = C - ezQ^e = C - e(C - F)$ since $C = F + ezQ^e$ or $C - F = ezQ^e$ so, continuing

$I - C = -e(C - F)$ or

$C - I = e(C - F)$ so

$e = (C - I)/(C - F)$ by rearranging the terms to isolate e. [22]

Benchmark cases can be used to exhibit the influence of these factors as volume drops. If C = I, then e equals zero, and vice-a-versa. By direct substitution in the cost function with $e = 0$, gives

$C = F + zQ^0 = F + z$, and since C = F when Q = 0, F = C and z = 0.

Looking at the ratio of average costs at the two different volumes then gives

$$AC_2/AC_1 = [\frac{F}{Q_2} + zQ_2^{e-1}]/[\frac{F}{Q_1} + zQ_1^{e-1}] = \frac{F}{Q_2}/\frac{F}{Q_1} = Q_1/Q_2 = Q_1/xQ_1 = 1/x \text{ since } z = 0 \text{ and}$$

$AC_2 = (1/x)AC_1$.

Assuming that all costs are fixed is an extreme example since Report 2 shows that F is actually closer to 20 percent of all costs. As x decreases from one, average unit costs, AC_2 increases inversely proportional to the Postal Service's unit cost in 2013, AC_1. For example, if the average unit cost for 2013 is 33 cents then the estimated costs would be 41.25 cents if x = 0.8 corresponding to a 20 percent decrease in volume. This would be slightly more than a 26 percent increase in average unit costs.

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[21] These cost elements are all known amounts from annual CRA reports and are all introduced here for the purposes of creating the illustrative example.
[22] Note that e is the elasticity of the variable portion and not the elasticity of C which is marginal cost of C divided by unit average cost.

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At the other benchmark extreme, assume that F = 0, then substituting in the above general form for *e* gives

$$e = (C - I)/(C - 0) = (C - I)/C = 1 - (1/C)$$

$$AC_2/AC_1 = [zQ_2^{e-1}]/[zQ_1^{e-1}] = [z(xQ)_1^{e-1}]/[zQ_1^{e-1}] = x^{e-1} = x^{(1-1/C)-1} = x^{-1/c} \text{ or}$$

$$AC_2 = x^{e-1} \ AC_1$$

If the 2013 unit costs are taken as 33 cents then the estimated unit cost at 80 percent of the 2013 volume is 36 cents a 3 cent or 4.4 percent increase.

In both benchmark examples, a drop in volume results in an average unit cost increase. For values of fixed costs between 0 and total institutional costs, i.e., 0<F< I, an illustrative numerical example provides further insight into the respective roles of fixed costs and elasticity on average unit costs.
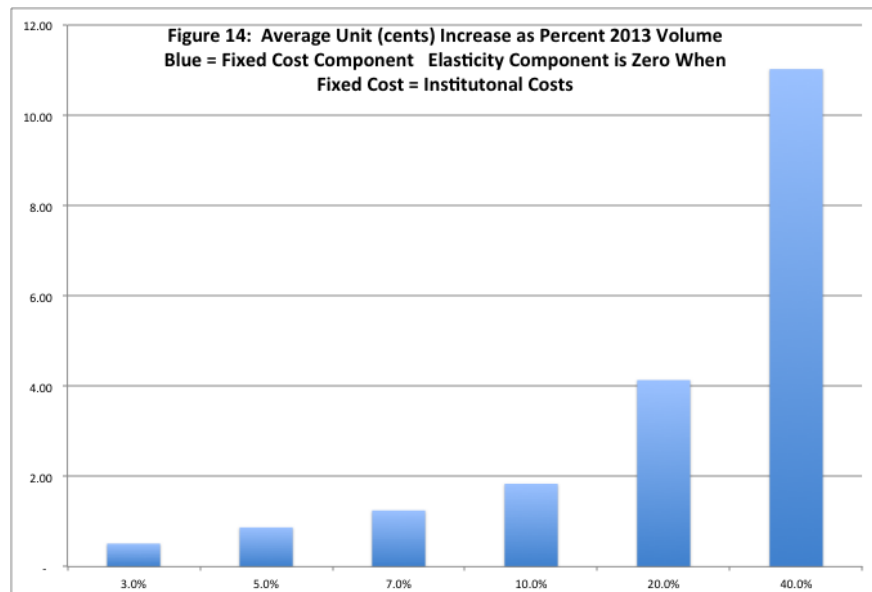
Consider *i* = 1 as the Postal Service with the 2013 volume, total costs and institutional costs. Further, assume that fixed costs equal institutional costs. Then, using the above equation for *e*, with I = F, gives

$$e = (C-I)/(C-I) = 1$$

Fitting the cost equation to these values requires that *z* = 0.24.

Then the growth in average unit costs due to a 3, 5, 7 etc. percent loss from 2013 volumes is given in Table 8 and Figure 14. The third row reflects the effect of the fixed costs on average unit cost increases

Table 8: A
x = percent of 2013 Volum
Percent Volume Loss from 2013 Vol
[F/Q1][1-1/x] with F =2013 Inst $
zQ1^(e-1)[1-x^(e-1)
AC2-AC1= Sum of above
due to the percent loss in
volume given in the
second row. The fourth
row reflects the effect of
the elasticity, which in
this case is absent

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Figure 14: Average Unit (cents) Increase as Percent 2013 Volume
Blue = Fixed Cost Component   Elasticity Component is Zero When
Fixed Cost = Institutonal Costs

because costs are constant. These are total average unit costs so do not reflect attributable or infra-marginal costs.

As volume drops by 5 percent, the unit cost increases by 0.87 cents due to the fixed costs. Note that the elasticity component does not come into play in this case. Also, the fixed cost component of the difference is the same shorthand assumption frequently made in calculating the change in average unit costs; i.e. treating all institutional costs as fixed and calculating only the effect of the fixed cost.

Now assume that the fixed costs are one half of the 2013 institutional costs. Continue to use the 2013 volumes, total costs and institutional costs. Then calculating e with the above formula gives a new elasticity of

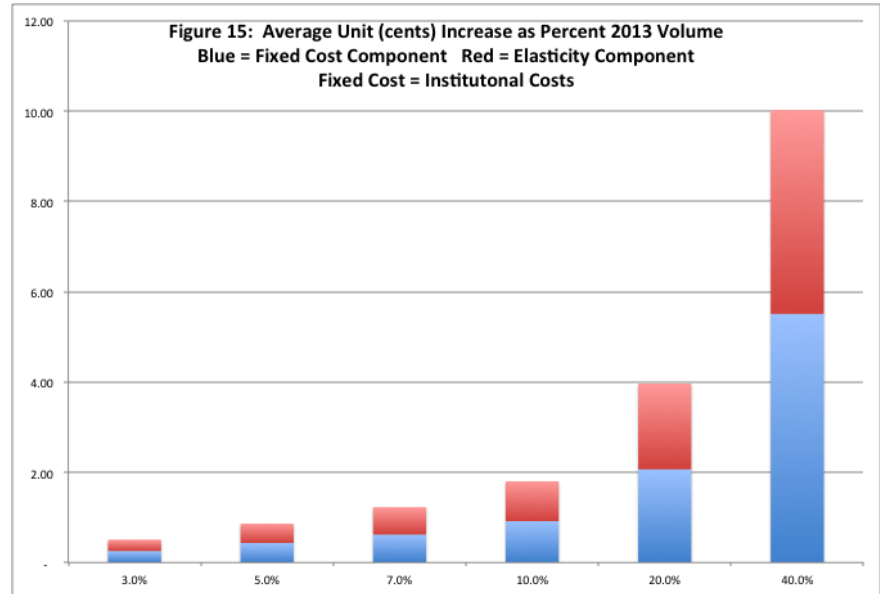$e = (C - I)/(C - ½*I) = 0.74$ with 2013 total and Institutional Costs

With a value of z equal to 41.74, the assumed cost function approximates the 2013 Postal Service costs. The calculated unit costs for different volume losses are given in Table 9 and Figure 15, which has a much smaller slop increase as volume drops. When volume loss is 5 percent of 2013 volume, the unit

Table 9: Average Unit Increases when $C = C(Q_i) = F + zQ_i^e$ and F = 1/2 of Institutinal Costs

x = percent of 2013 Volume	0.97	0.95	0.93	0.90	0.80	0.60
Percent Volume Loss from 2013 Vol	3.0%	5.0%	7.0%	10.0%	20.0%	40.0%
[F/Q1][1-1/x] with F =1/2 2013 Inst $	0.26	0.44	0.62	0.92	2.07	5.51
zQ1^(e-1)[1-x^(e-1)	0.25	0.43	0.61	0.88	1.90	4.51
AC2-AC1= Sum of above	0.51	0.86	1.23	1.80	3.97	10.03

cost increases 0.86 cents, with 0.44 cents due to the fixed cost component and 0.43 cents due to the elasticity component. This is also the increase when Fixed Cost equals Institutional Cost. But the effect is due to the fixed component.

This indicates that, for volumes losses less than 10 percent, the simplistic assumption of fixed costs equal institutional costs approximates the more realistic calculation of fixed and elasticity effects with fixed costs at half of institutional costs.

Figure 15: Average Unit (cents) Increase as Percent 2013 Volume
Blue = Fixed Cost Component   Red = Elasticity Component
Fixed Cost = Institutonal Costs

These are modeled costs with special assumptions. In reality, unit costs can behave quite differently due to changes in mail mixes, productivity and other factors. Between 2012 and 2013, volume decreased over SPLY from 2007 to 2013, but average unit costs in 2013 dollars decreased in 2007 and 2013. The SPLY percent change in average unit costs in the other years was positive, but at various rates relative to volume decreases as given in Table 10.

Table 10: Unit Cost (No RHB and No Workers Comp Adjustment							
Year	2007	2008	2009	2010	2011	2012	2013
Volume	212.2	203.1	177.1	170.9	167.9	159.9	158.4
Percent Change SPLY	-0.4%	-4.3%	-12.8%	-3.5%	-1.7%	-4.8%	-0.9%
Average Unit Costs $	0.33	0.34	0.38	0.38	0.39	0.41	0.41
Percent Change	-3.9%	4.3%	10.2%	0.9%	2.8%	3.9%	-0.6%
Average Unit Costs 2013 $	0.37	0.37	0.41	0.41	0.41	0.42	0.41
Percent Change 2013$	-6.1%	-0.1%	10.6%	-0.8%	0.2%	1.5%	-2.2%