# LINK RELATIVE ESTIMATION FOR MISSING WINDFALL PROFIT TAX RETURNS

James M. Harte and Bonnye Walker, Internal Revenue Service

This paper presents some results using link relative estimation to compensate for missing returns with relatively large amounts of windfall profit tax liability. Comprehensive information for the first quarter of 1982 indicates that there were 78 returns filed with tax liability (after adjustments) of $5,000,000 or more. The liability of this group totaled $4.7 billion. The left hand bar in Figure 1 shows the total split into two classes. The lower part represents the class of 60 filers whose returns were also available for our initial computations for the first quarter of 1983. The upper half represents the class whose returns were apparently missing when the later totals were compiled. The right hand bar shows the 1983 total reported from 60 of the 78 filers, as well as a question mark for an unknown missing amount. The problem of missing returns occurs because the totals are due on a fixed date, six months after the close of the quarter for which totals are compiled. The missing returns may not have been filed with IRS at the cut-off, or not have been picked up by the statistical operation. (See Appendix - Statistical Operations.)

After explaining link relative estimation and the windfall profit tax in a general way, the method will be illustrated by application to the problem posed in Figure 1. Additional link relative estimates are then presented for components of tax liability and compared to totals compiled from information available after the cut-off. This leads to an evaluation discussion.

Figure 1. Windfall Profit Tax (After Adjust-
ments) for First Quarter 1982 And As
Initially Reported First Quarter
1983.[1]



FIRST QUARTER 1982: $371 MILLION / $4,340 MILLION
FIRST QUARTER 1983: ? / $2,524 MILLION
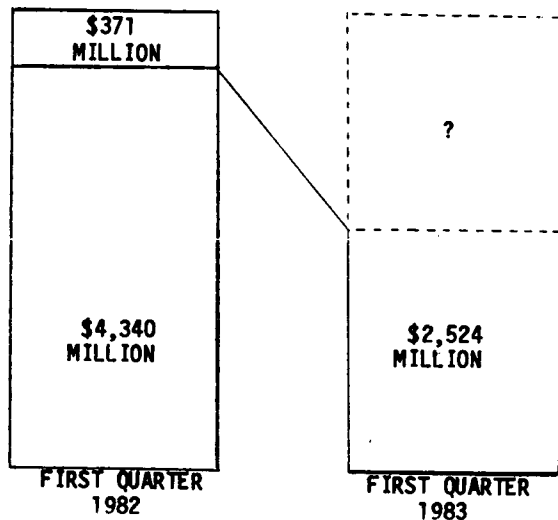
[1]·The figure is limited to filers with
$5,000,000 or more tax liability for first
quarter 1982.

## LINK RELATIVE ESTIMATION

Link relative estimation uses a benchmark obtained periodically together with a survey estimate of change for time periods between benchmarks. The measure of change is the product of link relatives. Some definitions needed to discuss the method are:

● A benchmark is an essentially complete total for a population.
● A link relative is a ratio of a total for a given period to the total for the same variable in the preceding period for units reporting for both periods.
● A link relative estimator of a total is the product of a benchmark and the link relatives for the periods of time between the benchmark and the current period.

The totals estimated by the method are considered random variables generated from a super-population rather than as fixed but unknown characteristics of a finite population. The underlying super-population model assumed here is the one discussed at the 1978 and 1979 meetings of the American Statistical Association by Lillian H. Madow and William G. Madow, [3-4]. In particular, the assumptions of the model are:

● the elements of the population are the same in all periods.
● for an element, the expected value of a characteristic is the value reported in the previous period times a constant. The link relative estimates this constant. Each characteristic has its own link relative.
● for a given time period and for a given characteristic, the values of the characteristic for the elements are uncorrelated.
● the variance of a characteristic for an element is the previous value times a constant. This second constant does not depend on the element and is not estimated by the link relative.

In our application of the method, the benchmark period is the first quarter of 1982. Link relatives are computed for the next four quarters. The survey measure of change is the product of the link relatives. Only the benchmark period is considered complete. The objective is to compute estimates for the first quarter of 1983.
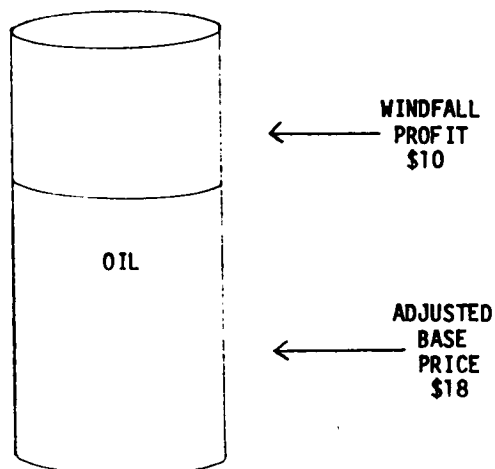
## THE WINDFALL PROFIT TAX

The windfall profit tax is a quarterly tax on domestic crude oil production. The latest published data show that since it was imposed in 1980 tax liability after adjustments totaled $61 billion through September 1983 [1]. The tax is imposed on those with an economic interest in the oil (producers and royalty owners, a numerous group). When the oil is sold, the tax is withheld by the purchaser. The purchaser files one return for all purchases during a calendar quarter. The number of returns filed has been in the 500 to 1,000 range each quarter.

Oil prices were controlled during the 1970's. In 1979 a phased decontrol of oil prices was begun and was completed in 1981. "Congress determined that the Crude Oil Windfall Profit Tax of 1980 was needed because of the Administration's decision to phase out price controls on crude oil, the recent increase in world oil prices and the nation's continuing overdependence on imported energy. The Act was intended to tax a fair share of the additional revenues received by oil producers and royalty owners as a result of oil price decontrol...." [2].

To illustrate the computation of the tax look at John Doe's oil barrel in Figure 2. It sold for $28, the removal value. For John Doe's oil field, an adjusted base price of $18 was established. This price reflects pricing history and an inflation factor. (State severance taxes would further reduce the windfall profit.) The difference between the market price $28 and the base price $18 was the windfall profit, $10. To obtain the tax, the windfall profit is multiplied by a tax rate. In the figure, the highest rate, 70 percent, is used so that $7 of the $10 windfall profit is tax. However, the windfall profit is reduced if it is more than 90 percent of the net profit on the oil. This adjustment is the net income limitation, the most important adjustment affecting the tax. John Doe would compute it annually on all his oil sales.

Figure 2. Illustration of Windfall Profit Tax

Removal Price Per Barrel = $28



WINDFALL PROFIT $10

OIL

ADJUSTED BASE PRICE $18

Tax = Windfall Profit X Tax Rate

$7   =   $10   X   .70

AN EXAMPLE

The elements of the population are the filers with tax liability after adjustments of $5,000,000 or more in the benchmark period. Link relatives are computed for the next four quarters. The number of returns of the benchmark filers available for each quarter and the number for those also available for the previous quarter are given below:

| Year | Quarter Covered | Current Filing | Current and Prior Filing |
|------|-----------------|----------------|--------------------------|
| 1982 | First           | 78             | -                        |
|      | Second          | 76             | 76                       |
|      | Third           | 68             | 68                       |
|      | Fourth          | 68             | 65                       |
| 1983 | First           | 60             | 59                       |

Figure 3 illustrates the computation of the link relative and measure of change for tax liability after adjustments. The paired bars represent the quantities used for computing the link relatives. The extreme right hand pair of bars shows that the link relative for the first quarter 1983, namely .8162 was based on the ratio of $2.5 billion to $3.1 billion reported by 59 filers. The measure of change .5879 is the product of the four link relatives shown.

Finally, the link relative estimate of windfall profit tax liability after adjustments is $2,769 million. This is $245 million more than reported. The question mark in Figure 1 would be replaced by $245 million.

MORE LINK RELATIVE ESTIMATES

Column 7 of Table 1 displays link relative estimates for components of windfall profit tax liability. In the process of determining the applicable tax rate, the crude oil sold is classified into Tier One, Tier Two, or Tier Three oil. Further classification is made within tiers. Most oil was Tier One oil. Oil was classified in Tier One unless it qualified as Tier Two or Tier Three. Most Tier One oil is taxed at the 70 percent rate; however, a 50 percent rate applies to the production of independent producers, up to 1,000 barrels a day. For informational purposes, Tier One oil is further classified as Sadlerochit Oil (from Alaska) and other oil.
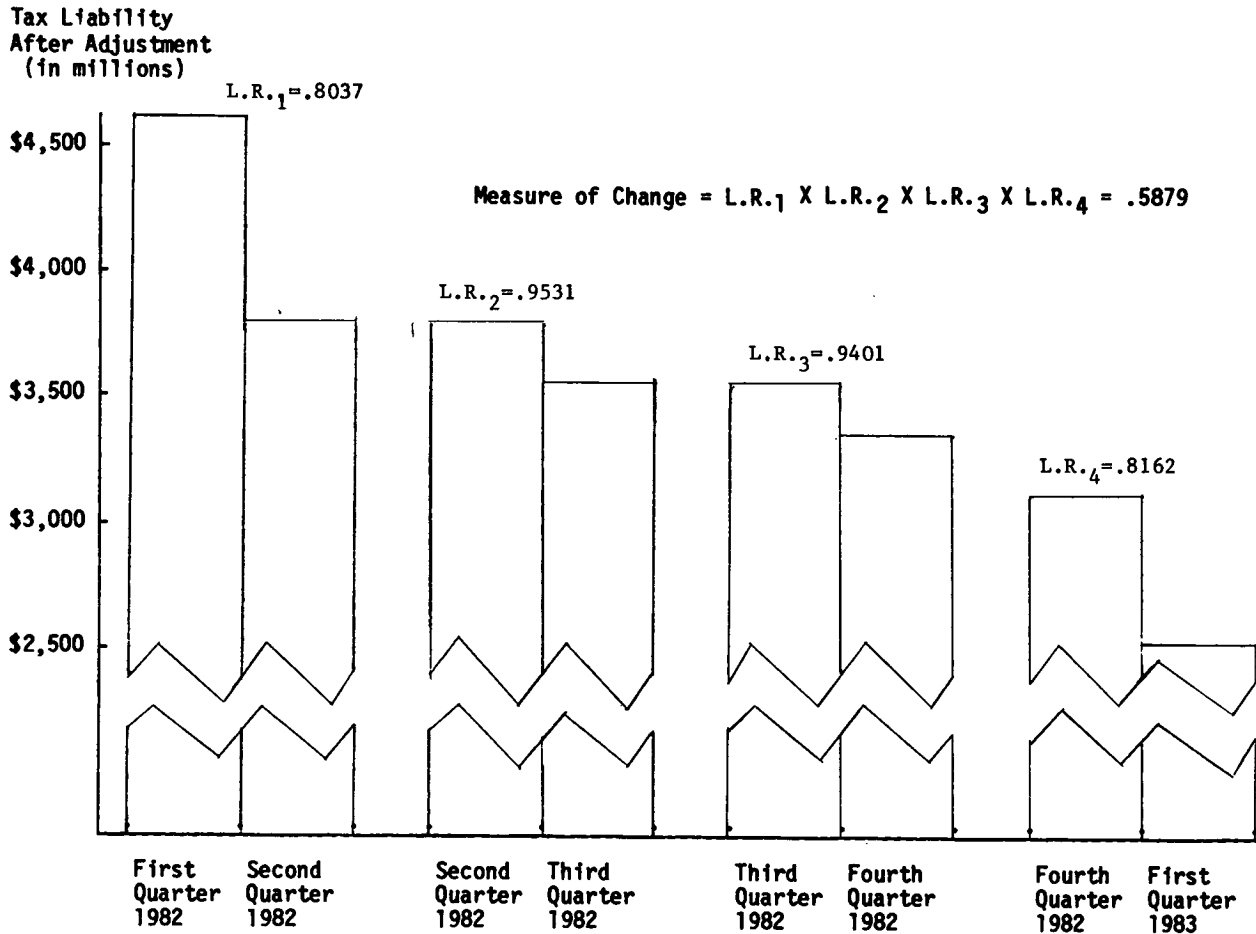
Tier Two oil was taxed at 60 percent, but for independent producers a special rate, 30 percent was applied to the first 1,000 barrels a day. Tier Two oil was from stripper wells, i.e., those with very small daily production, or was oil from a U.S. Naval Reserve.

Tier Three oil includes three special categories of oil which were taxed at 30 percent. However, starting with 1983, the rate on newly discovered oil is being reduced. For more details, see [1].

Table 2 gives the link relatives used in the computation of the estimates in Column 7 of Table 1. The overall measures of change are also presented in Table 2.

In Column 4 of Table 1 are the totals from returns available at cutoff for the first quarter 1983. The third total $2,524 million appears in Figure 1. The link relative estimate previously given is in Column 7. The totals in Column 6 reflect information available after the six months cutoff for statistics, and may be used to appraise the link relative estimates. The extra information is from returns secured after the cutoff date, or from

Figure 3. Link Relative Computation

Tax Liability
After Adjustment
(in millions)

$L.R._1 = .8037$

Measure of Change $= L.R._1 \times L.R._2 \times L.R._3 \times L.R._4 = .5879$

$L.R._2 = .9531$

$L.R._3 = .9401$

$L.R._4 = .8162$

$4,500

$4,000

$3,500

$3,000

$2,500

| First Quarter 1982 | Second Quarter 1982 | Second Quarter 1982 | Third Quarter 1982 | Third Quarter 1982 | Fourth Quarter 1982 | Fourth Quarter 1982 | First Quarter 1983 |

the accounts for the filers in the IRS computerized Business Master File (BMF) system. In the latter case, only tax liability and adjustments were available. The return counts are for returns with an item. Conventionally, all returns are considered to have a total tax before and after adjustments. A report from the BMF was also counted as a return.

With one exception, the totals in Column 6 and Column 7 are very close. The exception involves a problem of comparability. Link relative estimation did well for those items in the first quarter of 1983 based on a one year earlier benchmark and link relatives for the next four quarters. The exception was for the very small class of returns not reporting detail by oil tiers.

## FURTHER EVALUATION

By and large, the link relatives are not the net result of dissimilar changes, but reflect movement in unison by the individual filers. This is why the method worked so well. There seems no question that the link relative approach is superior to treating missing filers as if they report zeros.

In practice, previous returns for some very large filers have been substituted and the other missing returns ignored. Because of the down trend in the series, this has worked fairly well. The upward bias from partial substitution had been offset by the downward bias from non-response. Across the board substitution for all missing returns would have been a very poor strategy.

In applying link relative estimation we would have to cope with the fact that the estimates are not arithmetically consistent. For instance, the components of tax liability should add to the total tax liability, but the corresponding link relative estimates do not. In Column 7 of Table 1, the estimates of liability component, add to $2,928 million, while the separately made estimate of the total is $2,921 million. Beside being non-additive, the estimates are not multiplicative. The formula for the windfall profit tax in Figure 2 does not work if separately made link relative estimates are substituted for the windfall profit and the tax.

These problems of consistency suggest that link relative estimates would be made for a few key items and other items be estimated in a

261

consistent way. The filers' returns for the benchmark or the interim periods could be useful in this process.

For this research, we initially defined a population of 78 filers. The first assumption of the Madows' Model A was that the population did not change. Tracing the population in Table 1, we see 78 returns in Column 1.

In Column 3, we see that 60 returns were available at compilation time and we note in Column 5, there really were 69 returns altogether. Thus, we seem to have 9 deaths in the population. However, it is known that 4 of the 9 had tax liability decline to less than $1 million. They are represented by sample estimates as explained in the Appendix. The other 5 seem to have died. None of the 9 was very large in the benchmark period.

What about births? Birth is a fuzzy concept because of the dollar size criterion used in defining the population. Births would be a subset of filers which had come into existence since the benchmark period. How to specify the subset is moot. If new returns with large liability are missed, link relative estimation does not compensate for them. However, if they were born between the benchmark period and the current period we are probably aware of them. One large birth took place, but was not a problem.

The population we have studied is relatively stable and accounts for 90 percent or so of money totals. Link relative estimation would apparently improve the quality of the early statistical estimates.

Further study of other data items from the windfall profit tax return is in order. These include the windfall profit itself, the removal value of the oil, the adjusted base value and the number of barrels.

## ACKNOWLEDGMENTS

## REFERENCES

[1] Alexander, Michael, "Crude Oil Windfall Profit Tax, Third Quarter 1983," SOI Bulletin - Summer 1984, Internal Revenue Service, p. 109-116.

[2] U.S. Congress, Joint Committee on Taxation, General Explanation of the Crude Oil Windfall Profit Tax of 1980, Washington, D.C., 1981, p. 6.

[3] Madow, L. H. and Madow, L. G. "On Link Estimators," 1978 American Statistical Association Proceedings, Section on Survey Research Methods, pp. 534-539.

[4] Madow, L. H. and Madow, L. G. "On Link Relative Estimators II," 1979 American Statistical Association Proceedings, Section on Survey Research Methods, pp. 336-339.

## APPENDIX - STATISTICAL OPERATIONS

Form 6047, Windfall Profit Tax, is filed for by the purchaser of oil for all purchases each quarter. It is due, normally, two months after the close of the quarter, but extensions may be granted. It is attached to the Form 720 Federal Excise Tax Return, a return used for several other excise taxes as well. The returns are filed at the ten IRS Service Centers. Processing of the returns involves posting to the individual accounts in the computerized Business Master File (BMF) system. The accounts are associated with an Employer Identification Number (EIN). To meet the schedule for statistical compilation, returns are selected before information is entered into the BMF system.

Clerks in the Service Centers screen the Form 720 returns to see which have a Form 6047 attached. About 1 percent do. If the Form 6047 shows tax liability (before adjustments) of $1,000,000 or more, the return is selected for the sample survey with certainty. If lesser liability is shown, the nine digit EIN is inspected. If the last three digits of the EIN are in the range of 500-599, the return is selected. Otherwise not. If filers previously reporting $20,000,000 or more tax are missing, special searches are made. If returns in this class remain missing, it had been our practice to substitute earlier returns of the same filers prior to the current research.

No population counts are maintained during the sampling process so that the estimate of the total number of returns is a random variable. Estimation for returns with less than $1,000,000 liability uses a weight computed from two factors. On the basis of information from the BMF for earlier quarters an ideal weight is computed. The returns actually secured are checked against a list of those expected to be secured. A non-response factor is computed. The applied weight is the ideal weight times the non-response factor.

The statistics compiled are supplied to the Office of Tax Analysis of the U.S. Treasury Department. Later, they are published in the SOI Bulletin [1].

Table 1.--Windfall Profit Tax Liability by Oil Tier and Tax Rate: First Quarter 1982 Benchmark, First Quarter 1983 At and After Cutoff and Link Relative Estimates (in Dollars)

| OIL TIER AND TAX RATE | FIRST QUARTER 1982 BENCHMARK | | FIRST QUARTER 1983 AT CUT-OFF | | FIRST QUARTER 1983 AFTER CUT-OFF | | LINK RELATIVE ESTIMATE |
|---|---|---|---|---|---|---|---|
| | NO. RETURNS | AMOUNT | NO. RETURNS | AMOUNT | NO. RETURNS | AMOUNT | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| ALL RETURNS: | | | | | | | |
| Tax Liability Before Adjustments. | 78 | 4,919,212,297 | 60 | 2,690,246,236 | 69 | 2,919,050,007 | 2,921,055,130 |
| Total Adjustments.................. | 57 | 208,610,117 | 48 | 165,953,626 | 51 | 166,230,393 | 170,933,511 |
| Tax Liability After Adjustments.. | 78 | 4,710,602,180 | 60 | 2,524,292,610 | 69 | 2,752,819,614 | 2,769,153,876 |
| RETURNS REPORTING TAX LIABILITY BEFORE ADJUSTMENT BY OIL TIER AND TAX RATE: | | | | | | | |
| Tier One, Other Than Sadlerochit Oil: | | | | | | | |
| Taxed at 70 Percent........... | 70 | 3,335,497,398 | 53 | 1,952,002,735 | 56 | 2,002,904,943 | 2,149,735,429 |
| Taxed at 50 Percent........... | 61 | 202,032,431 | 50 | 128,045,838 | 53 | 130,933,965 | 135,405,698 |
| Tier One, Sadlerochit Oil | | | | | | | |
| Taxed at 70 Percent.......... | 12 | 343,037,016 | 7 | 92,763,124 | 8 | 93,199,073 | 93,470,716 |
| Taxed at 50 Percent*......... | - | - | - | - | - | - | - |
| Tier Two Oil: | | | | | | | |
| Taxed at 60 Percent.......... | 63 | 389,425,438 | 48 | 208,004,551 | 51 | 211,961,258 | 216,568,856 |
| Taxed at 30 Percent.......... | 61 | 109,892,498 | 46 | 10,055,325 | 49 | 10,241,262 | 10,689,542 |
| Tier Three Oil** | | | | | | | |
| Newly Discovered Oil......... | 66 | 198,283,432 | 51 | 98,327,026 | 54 | 99,675,865 | 108,760,345 |
| Incremental Tertiary Oil..... | 33 | 32,704,397 | 36 | 33,838,634 | 39 | 34,217,414 | 34,483,537 |
| Heavy Oil.................... | 31 | 56,584,368 | 28 | 17,146,566 | 29 | 17,217,200 | 17,728,380 |
| RETURNS NOT REPORTING TAX LIABILITY BEFORE ADJUSTMENT BY OIL TIER AND TAX RATE | 7 | 251,755,319 | 5 | 150,062,437 | 11 | 318,699,027*** | 160,991,974 |

* The number of returns and amount in this category have been combined with the Tier One Sadlerochit Oil taxed at the 70 percent rate to avoid disclosure of information about individual businesses.
** Taxed at 30 percent except for 1983, when Newly Discovered Oil was taxed at 27.5 percent.
*** This figure is not comparable to the link relative estimate because it includes cases based on limited information from the BMF, which were not similarly classified in the benchmark. A reclassification using item imputation indicates that $156,989,972 was a more comparable figure. The tabulated figure is a residual needed to make the column totals add to the total tax.

Table 2.--Link Relatives and Measure of Change by Oil Tier and Tax Rate

| Tax Liability by Oil Tier and Tax Rate | Link Relatives | | | | Measure of Change |
|---|---|---|---|---|---|
| | T = 1 1st and 2nd Quarter 1982 (1) | T = 2 2nd and 3rd Quarters 1982 (2) | T = 3 3rd and 4th Quarters 1982 (3) | T = 4 4th Quarter 1982 & 1st Quarter 1983 (4) | (5) |
| **ALL RETURNS** | | | | | |
| Tax Liability Before Adjustments ......... | .82604 | .99427 | .98350 | .73513 | .59381 |
| Total Adjustments ....................... | 1.32864 | 1.56208 | 1.34755 | 1.29298 | .81939 |
| Tax Liability After Adjustments .......... | .80374 | .95313 | .94013 | .81624 | .58786 |
| RETURNS REPORTING TAX LIAB. BEFORE ADJUST. BY OIL TIER AND TAX RATE: | | | | | |
| Tier One, Other Than Sadlerochit Oil: | | | | | |
| Taxed at 70 Percent ................. | .85960 | .96578 | .98724 | .78637 | .64450 |
| Taxed at 50 Percent ................. | .86617 | .98271 | .98345 | .80063 | .67022 |
| Tier One, Sadlerochit Oil: | | | | | |
| Taxed at 70 Percent ................. | .53905 | 1.47957 | .85470 | .39972 | .27248 |
| Taxed at 50 Percent* ................. | - | - | - | - | - |
| Tier Two Oil: | | | | | |
| Taxed at 60 Percent ................. | .81132 | .96606 | .99723 | .71151 | .55612 |
| Taxed at 30 Percent ................. | .83962 | 1.01817 | .96492 | .11792 | .09727 |
| Tier Three Oil:** | | | | | |
| Newly Discovered Oil ................ | .83828 | 1.01285 | 1.01463 | .63671 | .54851 |
| Incremental Tertiary Oil ............ | .68543 | 1.31131 | 1.27935 | .91695 | 1.05440 |
| Heavy Oil .......................... | .84858 | .73911 | .95468 | .52325 | .31331 |
| RETURNS NOT REPORTING TAX LIABILTY BEFORE ADJUSTMENT BY OIL TIER AND TAX RATE ............. | .76209 | 1.00202 | 1.03592 | .80839 | .63948 |

\* Combined with preceeding line.

\*\* Taxed at 30 percent except for 1983, when Newly Discovered Oil was taxed at 27.5 percent.