THE INADEQUACY OF UNIT VALUE INDEXES AS PROXIES FOR CANADIAN INDUSTRIAL SELLING PRICE INDEXES*

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This paper considers the adequacy of unit value indexes as proxies for industrial selling price indexes in Canada, in light of the considerations raised in the Searle report for the United States (summarized elsewhere in this issue). Some 3,237 regressions are run using the industrial selling price index for a commodity group as the dependent variable and the corresponding unit value index as the independent variable. The unit value indexes perform poorly as predictors of the I.S.P.I.; the overall tendency is for the unit value index to overestimate changes in the I.S.P.I., and to explain on average only about 30 percent of the total variance of the I.S.P.I.

I. INTRODUCTION

Industrial price change in Canada is measured in some manufacturing industries by industrial selling price indexes (I.S.P.I.) and in others by unit value indexes (U.V.I.). The I.S.P.I. are based on pricing of specified varieties of given commodities sold by particular establishments all selected to be representative of the particular industry for which price change is being measured. The unit value indexes are obtained by dividing the value by the number of units of output within commodity classes from data provided by the Census of Manufactures.

Opinions have differed strongly concerning the relative merits of the two forms of pricing. With the I.S.P.I., it is feared that list rather than transaction prices are likely to be obtained from sellers, and since the sample of commodities is necessarily very small relative to the population size, which is virtually infinite, the possibility of sampling errors in the I.S.P.I. loom large in the eyes of some. At the same time, the I.S.P.I. do provide measures of price changes in given varieties of given commodities over time, except where new varieties or commodities are consciously spliced into the indexes in response to changing market conditions.

The U.V.I., on the other hand, being based on the Census of Manufactures, do reflect transactions rather than list prices and do not contain appreciable sampling error. However, the U.V.I. are obtained for quite heterogeneous groupings of commodities so that year to year changes in these indexes may reflect, in part, changes in product mix within the group rather than price changes. This latter disadvantage of the U.V.I. is, of course, disqualifying if the year to year changes in product specifications and types of transactions within commodity groups outweigh the effects of pure price changes on the U.V.I.

*The author gratefully acknowledges the assistance of The Canada Council and Statistics Canada in the preparation of this study. Particularly helpful comments were made by Miss Betty Emery and Miss Ruth Simonton of Statistics Canada.

II. The Searle Report

A recent study has been done in the United States in which comparison is made between detailed (7 digit) unit value data from their Census of Manufactures and specification price data from their Wholesale Price Indexes for the periods 1954–58 and 1958–63(3). This study concludes that any gains in precision which may arise because unit values reflect a comprehensive universe and actual transactions prices are more than offset by problems of product and transactions mix. In other words, 7-digit Census products generally include a relatively wide range of product specifications and types of transactions and the mix may change markedly from year to year, so that the unit value indexes may reflect in large part these changes in product mix and types of transaction as well as price changes. Consequently, the unit value indexes provide less adequate measures of price change than the price indexes obtained from the W.P.I. Additional problems noted with the unit value indexes are an increasing number of small establishments which do not report product detail including quantities information, and the increasing complexity of manufactured products which adversely affects the derived unit values. This latter point also places some burden on price indexes in maintaining representativeness and adjusting for quality change.

This U.S. study concludes that specification prices are conceptually the most appropriate method of measuring price changes and should be used as deflators in the absence of positive evidence of their unsuitability. Unit values, they conclude, should be used only when the unit values selected are representative of a central tendency *and* when one or more of the following conditions hold:

1. Production is seasonal and erratic
2. The W.P.I. fail to reflect transactions prices
3. The W.P.I. are based on unreliable secondary sources
4. The W.P.I. are based on delivered prices rather than f.o.b. factory prices
5. The W.P.I. are unrepresentative of heterogeneous Census product line
6. The W.P.I. are not published and are therefore suspect
7. No W.P.I. are available.

In other words, the findings of this study are that the unit value indexes are generally unsuitable measures of price change because the 7-digit product line generally includes a wide range of differing products, package sizes, or large and small items. In some cases, however, the unit value indexes might be considered valid if the 7-digit product is narrowly defined by product description and terms of sale, and if for one of the various reasons given above the W.P.I. are found to be invalid.

III. Implications for Canadian Measures of Industrial Prices

These general conclusions undoubtedly apply to comparisons of the Canadian I.S.P.I. and unit value indexes; the I.S.P.I. are undoubtedly generally the better measures of price change when they are available. However, Table 1 shows that the I.S.P.I. are often not available even within the manufacturing sector, and in those cases, unit value indexes are now being used as deflators. The question of how important it is to extend the coverage of the I.S.P.I. depends

TABLE 1

MANUFACTURING INDUSTRIES NOT FULLY COVERED BY INDUSTRIAL SELLING PRICE INDEXES

Manufacturing Major Group	SIC Code
1	All covered
2	All covered
3	All covered
4	1792, 1799
5	2110, 2140, 2150, 2180, 2210, 2291, 2292, 2299
6	All covered
7	2432, 2441, 2442, 2450, 2460, 2491, 2499
8	2591, 2599
9	2680
10	All covered
11	2860, 2870, 2880, 2890
12	All covered
13	3010, 3020, 3030, 3080, 3090
14	3150, 3160, 3180
15	3210, 3240, 3260, 3270, 3290
16	3350
17	3520, 3530, 3540, 3550, 3562, 3590,
18	3690
19	3710, 3799
20	3811, 3813, 3814, 3815, 3830, 3840, 3931, 3932, 3950, 3970, 3983, 3984, 3985, 3986, 3987, 3995, 3996, 3997, 3998, 3999

Source: Prices Division, Statistics Canada.

in part on the degree of difference in the two measures of price change, and it is this point which we subsequently consider.

The following empirical results are based on 3,237 regressions run using the I.S.P.I. for the commodity group as the dependent variable and the corresponding unit value index as the independent variable. The regression results show the industry code, the commodity codes used by both the Input Output Division and the National Output and Productivity Division of Statistics Canada along with the regression coefficients, their t values, and the corresponding coefficient of determination ($\bar{r}^2$)—corrected for degrees of freedom. Each regression includes 7 observations which are the I.S.P.I. and unit value indexes for the years 1961–67. In cases where the data were suspect due to apparent clerical errors, the results of the regressions are not included in the summary below.

Ideally, one would like to obtain regression equations in which the constant term is zero and both the slope of the equation and the coefficient of determination are equal to unity. This would indicate that the unit value indexes are identical to the I.S.P.I. so that changes in the unit value indexes correspond perfectly to changes in the I.S.P.I. This, of course, is rarely the case, and the basic data enable one to identify the particular commodities which meet these ideal conditions. There are only 2 of the 3,237 regressions for which the unit

value indexes provided perfect measures of the I.S.P.I. in the years 1961–67. These commodities are identified below:

TABLE 2

COMMODITIES WHOSE UNIT VALUE INDEXES PROVIDE PERFECT MEASURES OF THEIR INDUSTRIAL SELLING PRICE INDEXES

Industry Code	Commodity Codes	
	Input–Output	National Output
1050	069	068
3540	601	602

In addition to these 2 cases whose U.V.I. and I.S.P.I. are identical in all 7 years, there are another 27 cases in which the U.V.I. and the I.S.P.I. differ by at most 0.1 in any year. These cases of near perfect representation of the I.S.P.I. by the U.V.I. are identified in Table 3 below:

TABLE 3

COMMODITIES WHOSE UNIT VALUE INDEXES PROVIDE NEAR PERFECT MEASURES OF THEIR INDUSTRIAL SELLING PRICE INDEXES

Industry Code	Commodity Codes		Constant	Slope	$\bar{r}^2$
	Input–Output	National Output			
2520	215	064	.053644	.999507	.99996
3090	343	170	− .053176	1.00131	.999924
3590	435	012	− .066572	1.00110	.998906
2520	534	633	.157847	.998596	.999939
2520	534	636	− .825090	1.00824	.999459
2591	445	604	− .254112	1.00277	.999757
2591	501	605	.831055	.991825	.999823
2591	501	606	.019957	1.00020	.999754
2610	182	628	− .240271	1.00269	.999630
2710	209	604	− .068123	1.00098	.999952
3050	314	612	.469050	.995437	.999941
3060	330	021	.000287	1.00083	.999999
3070	363	078	− .152302	1.00218	.999904
3090	260	163	.429901	.996084	.999357
3090	343	171	− .140166	1.00191	.999925
3470	418	005	.003404	1.00038	.999330
3520	424	613	− .319652	1.00335	.999614
3520	046	614	.341136	.997133	.999577
3540	424	603	−1.02937	1.01016	.996883
3550	429	021	.035226	1.00008	.999816
3561	048	608	− .146342	1.00191	.998123
3570	047	613	.322940	.997078	.999670
3590	435	011	− .149107	1.00168	.999152
3590	048	610	.252464	.997615	.999489
3590	048	611	− .727566	1.00799	.999560
3590	481	613	.333720	.997620	.999589
3590	048	616	− .166208	1.00194	.999495

Altogether then, there are 29 cases out of 3,237 in which the U.V.I. provided perfect or near perfect representation of changes in the I.S.P.I. In addition to this small group we identify three other larger groups in which the performance of the U.V.I. is much less satisfactory.

1. *Cases where the slope is negative and the constant term positive*

With these commodities the unit value indexes are very poor estimators of the I.S.P.I.—so bad, in fact, that the estimated change tends on average to be in the wrong direction (i.e. an increase in the unit value index tends to be associated with a decrease in the I.S.P.I. and vice versa). Of the 3,237 regressions, 901 fall in this class. A summary of the 901 regressions is given in Table 4 below:

TABLE 4

SUMMARY OF REGRESSIONS IN WHICH THE SLOPE IS NEGATIVE AND THE CONSTANT TERM POSITIVE ($n = 901$)

Coefficient	Mean	Standard Deviation	Maximum	Minimum
Constant	121.05	29.20	436.62	90.50
Slope	−0.19	0.28	0.0	−3.30
$\bar{r}^2$	0.07	0.27	0.99	−0.34*

*Note that because of the small sample size the correction for degrees of freedom can lead to negative values of $\bar{r}^2$.

2. *Cases where the slope is on the interval zero to one (i.e. including zero and one)*

This is the largest of all the groups including 1,987 of the 3,237 regressions. In these cases, increases (or decreases) in the unit value indexes overestimate increases (or decreases) in the I.S.P.I. but unlike regressions with negative slopes, the estimate tends at least to be in the right direction. The problem of overestimates of changes in the I.S.P.I. by changes in the unit value index is, of course, worse the smaller the slope in this zero to one range. Table 5 summarizes the 1,987 regressions included in this group:

TABLE 5

SUMMARY OF REGRESSIONS IN WHICH THE SLOPE IS ON THE INTERVAL ZERO TO ONE ($n = 1987$)

Coefficient	Mean	Standard Deviation	Maximum	Minimum
Constant	66.34	31.26	138.77	−8.41
Slope	0.34	0.30	1.00	0.00
$\bar{r}^2$	0.32	0.39	1.00	−0.84

3. *Cases in which the slope is greater than one*

With these 320 commodities increases (or decreases) in the unit value indexes underestimate the increases (or decreases) in the I.S.P.I. and the problem

is more serious the larger the slope. Table 6 summarizes the 320 regressions in this group.

TABLE 6

SUMMARY OF REGRESSIONS IN WHICH THE SLOPE IS GREATER THAN ONE ($n = 320$)

Coefficient	Mean	Standard Deviation	Minimum	Maximum
Constant	−21.59	38.96	24.00	−337.09
Slope	1.27	0.37	4.19	1.00
$\bar{r}^2$	0.77	0.23	1.00	0.04

In addition we have in Table 7 a summary of the results obtained from all 3,237 regressions.

TABLE 7

SUMMARY OF ALL REGRESSIONS ($n = 3237$)

Coefficient	Mean	Standard Deviation	Maximum	Minimum
Constant	72.45	50.85	436.62	−337.09
Slope	0.29	0.51	4.19	−3.30
$\bar{r}^2$	0.30	0.40	1.00	−0.84

Overall, it is apparent that the unit value indexes perform poorly as predictors of the I.S.P.I. In less than 1 per cent of the cases examined did the U.V.I. provide perfect or near perfect representation of the I.S.P.I. and the overall tendency is for the unit value index to overestimate changes in the I.S.P.I. This suggests that changes in commodity mix tend to reinforce pure price changes in the unit value indexes. With rising commodity prices there would seem to be a shift towards larger and more expensive items in the commodity, group and conversely with falling commodity prices. This is a general tendency, however, and not a universal phenomenon. In about 10 percent of the cases examined, we found that the unit value indexes underestimated changes in the I.S.P.I. and worst of all, in about 28 percent of the cases, we found an inverse relationship between changes in the two indexes. When one adds to all of this the fact that, overall, the unit value indexes "explain" on average only about 30 percent of the total variance of the I.S.P.I., one obtains a very unsatisfactory impression of unit value indexes as measures of price change. The need for extension of the I.S.P.I. to cover those manufacturing industries not now covered would seem to be obvious.

No doubt those manufacturing industries not now covered lack homogeneity which makes the construction of reliable I.S.P.I. difficult. However, one must remember that it is in precisely those instances where commodity groups lack homogeneity that the unit value indexes are most suspect. Consequently, what is

relevant is whether specification pricing or some other approach can be employed to improve on unit value indexes as measures of price change, and there would seem little doubt that they can if the effort is made. Application of the method developed by Dacy (1) could be made to non-homogeneous product groups not only within manufacturing but in other industries as well, if it is found that specification pricing techniques are unsatisfactory. Selling price indexes are needed in the distribution and transportation industries, construction, heavy durables and a broad range of service industries, as well as manufacturing. Work has been done over the past 5 years by the Prices Division of Statistics Canada on the development of price indexes for construction and other capital expenditures. Much work remains to be done, however, in developing an adequate set of industry selling price indexes for Canada.

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