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The Cyclical Sensitivity of Prices: The Cumulative Density Approach

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THE CYCLICAL SENSITIVITY OF PRICES: THE CUMULATIVE DENSITY APPROACH

In this paper I continue the examination of the post-1950 cyclical behaviour of prices in Canada begun by Ferley, O'Reilly and Dunnigan [4] from two aspects -- average price changes and relative price variability. Two questions are considered. First, is it possible to identify intertemporal changes in the cyclical behaviour of Canadian prices? Second, does the cyclical behaviour of Canadian prices depend on the characteristics of product markets? It should be emphasized that the goal here is not to explain the cyclical behaviour of prices but rather to identify important characteristics of price behaviour that should be explained by a successful econometric model. The approach is descriptive and statistical rather than econometric.

The paper is comprised of six sections. The first contains a brief description of the basic methodology. In section 2, I briefly review work by Cagan [2] and Encaoua [3] using a cumulative density approach to the cyclical behaviour of prices. The general cyclical behaviour of Canadian prices is investigated in section 3. Section 4 contains evidence about the cyclical price behaviour in different types of product markets. In the fifth section the results of this work are compared to the results of similar work by Encaoua on Canadian data. Then both sets of Canadian results are compared to Cagan's U.S. results. Some conclusions are suggested in the final section.

1 The Basic Methodology

In Ferley, O'Reilly and Dunnigan, weighted price index data were used to investigate the cyclical sensitivity of prices. There are problems with this approach in that apparent changes in the cyclical sensitivity of an index over time may be due to changes in the coverage of the index or to weight shifts involving components with different inherent cyclical sensitivities. The alternative procedure employed here involves the use of unweighted disaggregated data. The methodology was first used by Cagan. The idea, given a large number of disaggregate price series, is as follows. For each business downturn during the period of interest compute a measure of the change in each price. Then construct the cumulative density function of the price-change measures for each recession period.

Each cumulative density function relates sample proportions, on the vertical axis, to values of the price-change measure, on the horizontal axis. For example, suppose that eleven price series are available

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and that, for a particular recession, the eleven price-change measures are -21.0, -10.5, -7.4, -6.3, -5.2, -3.0, -2.8, -2.0, -0.5, 1.5 and 3.2. The cumulative density function for these data is plotted in Figure 1. Note that a vertical line drawn through the value -3.0 on the horizontal axis intersects the function at a point corresponding to 0.5 on the vertical axis. This indicates that 50% of the price-change measures in the sample are less than -3.0.

Comparison of cumulative density functions for various recessions can provide evidence about changes in overall price sensitivity between recessions as well as changes in relative price variability. If the cumulative density function for a particular recession lies to the left of the density function for a second recession when the two are plotted on a common graph, there is, ceteris paribus, evidence that prices were more sensitive to the first downturn than to the second. If the density function for one downturn is flatter than the function for another recession there is evidence that the variance of the price-change distribution for the first recession was larger than the variance of the second price-change distribution. This indicates that the variability of relative prices was greater during the first recession. Note the use of the phrase "there is evidence". Comparison of cumulative density functions cannot provide definitive proof about changes in price behaviour unless they are constructed using data on all prices in the economy. When only a sample of prices is observed, the interpretation of differences between cumulative density functions can be facilitated by the use of statistical tests.

2 Review of Selected Earlier Work

Cagan [2] used cumulative density functions to examine the cyclical behaviour of U.S. wholesale prices during the period 1947-70. He constructed cumulative density functions of price changes for six periods of recession and economic slowdown. He found that the dispersion[1] of the price-change distribution for the 1948-49 recession was considerably larger than the dispersions for later recessions, indicating that the 1948-49 recession was a period of high relative price variability. He also observed that the cumulative densities generally shifted to the right over time, indicating a decline in the sensitivity of prices to recessions. Cagan recognized that the overall increase in inflation during the period considered might be responsible for the observed rightward shifts. However, when he recomputed the cumulative densities using price-change measures corrected for price trends the same result, that is, a trend decrease in the cyclical sensitivity of prices, was observed.

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1. Cagan used average absolute deviation from the mean as a dispersion measure.

In further analysis Cagan ascertained that the trend decrease in sensitivity was not confined to high value-added or concentrated manufacturing industries. Cagan interpreted his overall results to mean that an intensification of general anticipation of inflation over the postwar period had lessened the response of manufacturing prices to short-run variations in demand. Cagan believed that this had contributed to the postwar difficulty of curbing inflation through policies restraining aggregate demand.

Encaoua [3] used cumulative density functions to study cyclical changes in Canadian Industry Selling Price Index prices from the mid-1950s through 1980. He used price-change measures corrected for price trends. He found evidence of a decrease in the cyclical sensitivity of Canadian prices during the 1974-75 and 1979-80 recessions relative to the 1960-61 recession. He observed that considerably more prices increased at a rate below their trend rate of increase during the 1960-61 recession than during the 1974-75 and 1979-80 recessions. His cumulative density functions indicated that prices dropped further during the 1979-80 recession than during the recession of 1974-75. He observed that the variances of the price-change distributions for 1974-75 and 1979-80 were much higher than the variance of the distribution for 1960-61, indicating that relative price variability was higher during the later recessions. Encaoua computed mean price-change measures for a number of major indusry groups. He found that prices of leather and wood products have been consistently sensitive to cycles in Canada. Prices of paper, primary metals, petroleum, chemicals and rubber and plastics have been relatively insensitive.

In section 5 the work of Cagan and Encaoua will be considered again as the results of this paper are compared to those of similar studies.

3 The Cyclical Behaviour of Prices in General

Cumulative density functions were constructed for two sets of Canadian prices - a set of prices from the Consumer Price Index and a set of Industry Selling Price Index prices. In each case monthly data, seasonally unadjusted, were used. The selection procedure for the Consumer Price Index data was as follows. From series at all levels of aggregation, the subset of series available as far back as 1949 was selected. There were 130 such series. All cases in which a component series at a lower level of aggregation was duplicated in a more highly aggregated series were eliminated: the series at the higher level of aggregation was removed in each case. This procedure led to a final set of 97 series. The final set of series was spread reasonably well across all major CPI categories. An analogous procedure was used to select a set of Industry Selling Price Index series. Only series available back to

1956 were considered and the final set included 136 series.[2]

For this analysis, the peak and trough months of post-1950 recessions were identified according to Table 1 of Ferley, O'Reilly and Dunnigan. I then calculated two measures of the movement in each price series during each recession period for which data were available. The first measure, which will subsequently be called Cyclical Sensitivity Measure 1 (CSM1), was computed as follows. The average annual growth rate of each price series from the peak to the trough of each of the recessions was calculated. This rate was computed using the three-month moving average of the price level centred on the peak month and the three-month moving average centred on the trough month. Then each growth rate was corrected for the trend in the corresponding price. Each peak-to-trough growth rate was corrected by subtracting the average annual growth rate of the price over the preceding trough-to-peak period. After the correction was performed, CPI price changes were available for six post-1950 recessions. ISPI data were available for four recessions. Periods of economic slowdown were not used in this analysis.

The cumulative density functions of the CPI price changes, calculated using CSM1, for the 1953-54, 1957-58, 1979-80, and 1981-82 recessions are plotted in Figure 2A. In Figure 2C we have cumulative densities for CPI price changes during the recessions of 1960-61, 1974-75, 1979-80 and 1981-82. A casual inspection of these graphs suggests that the variances of price changes during the three most recent recessions, which took place in the high inflation environment of the 1970s and early 1980s, are larger than the variances of price changes in recessions prior to 1970. Given this variance difference, it is somewhat difficult to comment on differences between the means[3] of the distributions, although it appears from Figure 2C that prices dropped further on average during the 1981-1982 recession than in the 1979-80 and 1974-75 recessions, and further in 1979-80 than during the 1974-75 recession.

The cumulative density functions of the ISPI price changes for the four most recent recession periods are plotted in Figure 3A. These ISPI density functions show a pattern similar to the CPI functions. The 1960-61 recession stands apart from the others in its smaller variance,

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2. The series used here are all available on the Statistics Canada Cansim Base. The CPI series were selected from Matrix 300 and the ISPI series from Matrices 655-674. Based on 1982 weights the set of CPI series selected comprises about 55% of the overall index. For the ISPI, coverage is 30.7% using 1961 weights and 20.7% using 1971 weights.

3. Here and throughout the paper all comments about means refer to unweighted means.

and moreover, there is evidence that the average drop in prices has been greater over the last three recessions.[4]

It is important to note that I have adjusted each price change for the trend of the price, but not for any other variables to which it may be structurally linked. In particular, the price changes have not been adjusted for real effects. The use of the average annual rate of change over the entire preceding expansion period as a price trend correction is also open to objection. For example, in the case of the 1974-75 recession this measure involves averaging over a period of thirteen years during which there was a considerable acceleration of overall inflation.

To investigate the importance of the price trend correction a second set of cumulative density functions was generated: the average annual growth rate of the three-month moving average of each price during each recession period was corrected by subtracting its average annual growth rate over the one-year period immediately prior to the peak. This measure will be called Cyclical Sensitivity Measure 2 (CSM2). Figures 2B, 2D and 3B show the CSM2 cumulative density functions corresponding to the CSM1 density functions plotted in Figures 2A, 2C and 3A.

Comparison of Figures 2A and 2C against Figures 2B and 2D suggests that for the CPI the choice of trend inflation measure is relatively unimportant. Like the corresponding CSM1 densities, the CSM2 densities for recessions during the 1970s show higher variances than the densities for recessions prior to 1970. There is also some evidence in Figure 2D of an increase in cyclical sensitivity during the 1970s. Note however that this evidence is somewhat weaker than it is in Figure 2C. The CSM2 cumulative density for the 1974-75 recession corresponds to a probability density function that is skewed further to the left than the probability density function corresponding to the CSM1 cumulative density for 1974-75.

The choice of the measure for the trend inflation has a considerably greater impact in the ISPI case. Although both Figures 3A and 3B suggest an increase in the variances of price-change distributions for recessions during the 1970s relative to the 1960-61 recession, the increase in cyclical sensitivity over the three most recent recessions, suggested by the CSM1 densities, is not at all indicated by Figure 3B.

The means and standard deviations of the price changes used to generate cumulative density functions for the Consumer Price Index are

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4. The fact that prices in our sample dropped further in more recent recessions can be interpreted as evidence of a change in the cyclical sensitivity of prices only if one dismisses the possibility that the characteristics of the relevant product markets changed over time. The trend towards larger price declines might be consistent with a product life cycle model that suggested that product markets become more competitive over time. Encaoua [3] constructed cumulative density functions for CSM1 and CSM2 price changes during the 1974-75 recession. To construct the Encaoua functions all disaggregated ISPI series available during 1974-75 were used, including a large number of series added to the Cansim Base by Statistics Canada in the early 1970s. Comparison of the Encaoua functions and those constructed here indicates that the new prices were relatively insensitive to the 1974-75 downturn.

given in Table 1. The mean of the CSM2 price changes during the 1974-75 recession is much lower than the mean of the 1974-75 CSM1 price changes. The per cent decelerating column in this table gives the proportion of prices whose cyclical sensitivity measure was negative, that is, the proportion of prices which increased at a rate below trend during recessions. Similar statistics for the Industry Selling Price Index are given in Table 2. Since only a subset of the CPI and ISPI series have been used in each case, one cannot be certain that differences between means and standard deviations reported in these tables would hold up if all relevant prices were observed. The sign test, a nonparametric procedure, was used to test the statistical significance of the differences reported in Tables 1 and 2[5]; results of these tests for the CPI are summarized in Tables 3 and 4.

Table 3 describes tests for differences between mean price changes during the various recession periods. A "+" in row i and column j of this table indicates evidence at the 95% level of significance[6] that the true mean price change during recession i was more positive than the true mean price change during recession j. Here true mean price change indicates the mean of the price changes for all CPI series <u>including those not observed</u>. Similarly a "-" in row i and column j indicates evidence at the 95% level of significance that the true mean price change during recession i was more negative than the recession j true mean change. The probability of a more extreme difference between the observed means if the true means were actually equal is less than 5% in these cases. A "(+)" appearing in the table indicates that, for the majority of prices considered, the cyclical sensitivity measure computed for recession i was more positive than the measure computed for recession j but the difference was not statistically significant. Note that there is not complete agreement between "(+)"s and "(-)"s in Table 3 and the signs of differences of Table 1 means. The discrepancies are due to the effects of outliers. Extreme outliers can have a large influence in the calculation of arithmetic means. The sign test procedure gives less importance to outliers.

If one is looking for overall trends in the cyclical sensitivity of prices, the evidence of Table 3 is very mixed. If one considers CSM1, there is significant evidence of an increase in sensitivity over the two

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5. The assumptions behind this test and its computation are described in Armstrong [1].

6. The exact significance levels for these tests are slightly less than 95%. Two tests were conducted for every pair of sets of prices. A standard sign test was calculated as well as a modified sign test involving correction for differences between the sample variances of the two sets of prices. The corrected test is described in Armstrong. It is reported here that the null hypothesis of equal true mean changes was rejected at the 95% level of significance if the hypothesis was rejected by either the standard test or the modified test at the 95% significance level. This procedure was used for all tests for differences in true mean price changes reported in this paper.

most recent recessions. On the other hand a significantly large number of prices dropped further during the recessions of 1953-54 and 1957-58 than during the 1974-75 recession. There is some evidence of an increase in cyclical sensitivity over the recessions of 1953-54, 1957-58 and 1960-61. A significantly large number of prices dropped further during 1957-58 than during 1953-54 and a significantly large proportion of prices dropped further in the recession of 1960-61 than during the two previous recessions. This apparent trend towards increased sensitivity was interrupted by the 1974-75 recession in which significantly fewer prices dropped further than during the 1953-54 period. After 1974-75 the trend towards increased sensitivity resumed, starting from a different level. When CSM2 is used, prices appear more sensitive than they do with CSM1 during the 1957-58 and 1974-75 recessions. Note that although the mean price change in Table 1 is more negative for the 1974-75 recession than for 1979-80, the majority of prices dropped further in 1979-80.

Table 4 describes the results of tests for differences between the variances of CPI price changes over the recession periods. A "+" in row i and column j indicates evidence at the 95% level of significance[7] that the true variance of recession i price changes exceeds the true variance of recession j changes. A "(+)" in row i and column j indicates that for the majority of prices, the recession i change measure is farther from the recession i average than the recession j change is from the recession j average. However, the preponderance is not large enough to indicate a statistically significant difference between true variances. The results of Table 4 tell a much clearer story than those of Table 3. The recessions prior to 1970 all have variances significantly smaller than each of the recessions after 1970 regardless of whether CSM1 or CSM2 is used. This result is consistent with the stylized fact that relative price variability increased as the rate of inflation increased.

Tables 5 and 6 summarize the results of tests for differences between means and variances of ISPI price changes. The mean results, given in Table 5, are similar to the results for mean CPI price changes when one considers CSM1. There is significant evidence that the cyclical sensitivity of prices is increasing over time if one considers only the three most recent recessions. On the other hand, when CSM2 is used there is no evidence at all of a trend increase in cyclical sensitivity during the 1970s. A significant majority of prices dropped further in 1974-75 than during the 1979-80 recession. The variance results, summarized in

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7. The exact significance levels for these tests are slightly less than 95%. A standard sign test and a test involving a correction for differences between sample means was conducted for each pair of sets of prices. The corrected test is described in Armstrong. It is reported here that the null hypothesis of equal variances was rejected at the 95% level of significance if the hypothesis was rejected by either the standard test or the modified test at the 95% significance level. This procedure was used for all tests for differences in true variances reported in this paper.

Table 6, are similar to those obtained from the CPI. The variances of price changes during the three most recent recessions are significantly higher than the variance of changes during the 1960-61 recession regardless of whether CSM1 or CSM2 is used.

4 The Cyclical Behaviour of Prices in Particular Product Groups

To investigate the consistency of the overall results across different sorts of product markets, the set of 136 ISPI series was divided into five groups on the basis of product market characteristics -- closed (53 series), open (14), import-competing (37), export-oriented (27) and energy (5). The procedure used to classify series into these groups is detailed in Appendix 1. The means and variances of price changes for series in each of the five groups over the four most recent recessions are shown in Table 7. Two questions can be put to the data in Table 7. First, do changes in prices in one group consistently differ from changes in prices in another group in a particular way across all recessions? For example, do we have evidence that prices in the closed category are consistently more or less responsive to cycles than those in the open category? Second, how do changes in the cyclical sensitivity of prices in each group compare? For example, given that prices in the closed category became more sensitive to cycles over time, is there evidence that prices in the import-competing group behaved in the same way?

Table 7 provides some indication that the prices of products whose markets are relatively open to international competition are consistently more sensitive to cycles regardless of whether CSM1 or CSM2 is considered. Compare, for example, the mean price changes for the export-oriented and open categories to the mean price change for the closed category using either CSM1 or CSM2. In order to examine the suggestion that the cyclical behaviour of prices depends on product market characteristics, two statistical procedures were used.

First the null hypothesis of no product market effect was tested by computing Spearman rank correlation coefficients[8] between sets of price change measures for various pairs of recessions. In the absence of a product market effect there would be no tendency for a price-change measure for a particular product to lie below the average change in one recession given that it was below the average change in another recession. The Spearman rank correlation coefficients calculated for the overall group of 136 ISPI prices are reported in Table 8. In the absence of correlation a Spearman rank correlation coefficient calculated using 136 observations exceeds 0.27 less than 0.1% of the time. All the values in Table 8 are much higher than 0.27 -- strong evidence of a product market effect.

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8. Refer to Gibbons ([5], pp. 275-284) for documentation of this rank correlation statistic.

A second set of statistical tests was applied to the ISPI data classified into product market groups in an attempt to obtain more specific evidence about the effects of product market characteristics on cyclical price behaviour. For each recession a set of tests was computed for all possible pairs of product groups. In each case the null hypothesis was that the average price changes in the two product groups were equal. The Mann-Whitney test[9], a nonparametric procedure, was employed and the results are reported in Table 10. The symbols in this table have the same meaning as in Tables 3-6: "+" indicates that the average price change for products in the group indicated by the row heading was significantly more positive during the recession under consideration than the average price change for the product group designated by the column heading. A "(+)" indicates that the average price change for the row group was more positive than the average price change for the column group but that the difference was not statistically significant. Note that prices in the export-oriented category were generally significantly more sensitive to business downturns than prices in the import-competing and closed groups.

The Mann-Whitney procedure was also used to test for differences between the degree of relative price variability within each product group. The results of these tests are reported in Table 11. In general, relative price variability in the export-oriented group was higher than in the other groups although the difference was not always statistically significant.

Now consider the second question, that is, are any changes in the cyclical behaviour of ISPI prices consistent across all product groups? In general, the numbers in Table 7 suggest that the answer to this question is yes. In terms of relative size the means for each group generally correspond to the means of the overall data when either CSM1 or CSM2 is used. In some respects the 1979-80 recession is anomalous. Prices in the open and export-oriented groups were unusually sensitive compared to the overall results according to both CSM1 and CSM2. Prices in the import-competing group did not drop as much as usual during the 1979-80 recession whichever price-change measure is used. In addition, prices in the closed category did not fall as much as usual according to CSM2.

The variances for each group also conform to the most important overall results. The variances of price changes during the three most recent recessions were generally substantially higher than the 1960-61 recession variance. The 1981-82 recession was exceptional in that the variances of changes in prices in the closed and export-oriented groups were unusually small according to both CSM1 and CSM2.

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9. Refer to Pearson and Hartley ([7], pp. 46-48) for details of this procedure.

In order to examine the statistical importance of these anomalies the sign test procedure used to test for statistically significant differences between means and variances of all ISPI price changes was applied separately to each group of ISPI prices. The results of the tests can be found in Tables 12 and 13. In general, they are consistent with the results obtained from all data combined. When price changes are computed using CSM1 there is evidence of an increase in cyclical sensitivity during the two most recent recessions. With either CSM1 or CSM2 the variances of price changes for recessions during the 1970s are greater than the 1960-61 recession variance. None of the anomalies indicated above are statistically significant. Table 12, for example, would provide statistically significant evidence of a different trend in cyclical price sensitivity between price groups if, for example, a "+" in a particular position of a CSM1 sub-table corresponded to a "-" in the same position of another CSM1 sub-table. The fact that this is not the case may be a reflection of the relatively small number of prices in each group.

Two approaches were used to test for the importance of product market characteristics in the cyclical behaviour of Consumer Price Index prices. First, Spearman rank correlation coefficients were computed from the full sets of 97 prices for each pair of recessions. All the correlations, reported in Table 9, provide strong evidence against the null hypothesis of no product market effect. In a second approach to the product market question, the set of CPI prices was divided into two groups - a set of 23 prices of import-competing products and a group of 74 other prices. The procedure used to classify CPI series is described in Appendix 1. The means and variances of price-change measures for these two groups are reported in Table 14. This table does not provide any consistent evidence that the prices of import-competing products are any more or less sensitive to cycles than other CPI prices. Nor does it contain any statistically significant evidence that the relative prices of import-competing products have been more variable than the relative prices of other products in the CPI during recent recessions.

To investigate the effect of government regulation on price behaviour, the original set of 97 CPI prices was separated into a group of 21 regulated prices and a group of 76 unregulated prices. (Refer to Appendix 1.) The means and variances of price-change measures for these two groups are given in Table 15. Data are presented only for the three most recent recessions; the earlier recessions were excluded because many commodities that are regulated today were not regulated before 1970. Table 15 provides consistent and statistically significant evidence that relative price variability has been greater for the group of unregulated CPI prices than for the regulated price group. The evidence in terms of cyclical sensitivity is mixed. Both CSM1 or CSM2 show statistically significant evidence that unregulated prices dropped further on average than regulated prices during the 1981-82 recession. On the other hand unregulated prices were on average less sensitive to the downturn of

1979-80. This surprising result is due to the influence of some extreme outliers. The nonparametric Mann-Whitney test, which gives outliers a relatively low weight, confirmed that the average price drop was greater for the regulated group than for the unregulated group in 1979-80, although the difference was not statistically significant.

5 A Comparison of Results

To a certain extent the work here with Industry Selling Price Index data can be viewed as an extension of an earlier study by Encaoua [3], which used data through 1980. Encaoua constructed cumulative density functions for price changes using both CSM1 and CSM2. His data set for the 1960-61 recession was, except for slightly different cycle dating, almost the same as the data set used here. When Encaoua considered the 1974-75 recession his data set had been enlarged by inclusion of a large number of disaggregated ISPI series made available by Statistics Canada for the first time in the early 1970s. The new series were on average less sensitive to the recession of 1974-75 than those considered here. Using CSM1, Encaoua found that prices dropped further on average during the 1979-80 recession than during the 1974-75 recession. When 1974-75 is compared with 1979-80 using Encaoua's data set and CSM2, there is no evidence of a change in cyclical sensitivity. Encaoua observed that the variances of his price-change distributions were much greater for the 1974-75 and 1979-80 recessions than for the 1960-61 recession. These results were all observed in this study. Neither data for the 1981-82 recession nor CPI data were included in the Encaoua study. Moreover, Encaoua's work did not include any statistical tests for the significance of observed cumulative density function differences.

Encaoua divided the ISPI data into major industry groups and reported the means of price changes during various recessions for each of the groups. He suggested that industry groups that showed price flexibility during the 1974-75 recession also showed flexible prices during the 1979-80 downturn. This result is compatible with the evidence presented here that the characteristics of product markets affect the cyclical sensitivity of prices.

The main conclusion of the study by Cagan [2] with U.S. wholesale price data up to 1970 was that the cyclical sensitivity of prices declined during the period 1947-1970. Cagan used CSM1 as a price-change measure. A similar decline is not at all evident in Canadian data. All statistically significant differences observed using Canadian CPI data and CSM1 point to an increase in cyclical sensitivity over the same period. Table 3 indicates that a significant majority of CPI prices dropped further during the recession of 1960-61 than during the 1953-54 and 1957-58 recessions.

6 Conclusions

Examination of price-change distributions for Canadian CPI and ISPI prices corresponding to post-1950 recession periods suggests three main conclusions. First, the variances of these distributions are much larger for recessions during the 1970s and early 1980s than for recessions before 1970, indicating that the variability of relative prices has increased over time. Second, when one considers only the 1974-75, 1979-80 and 1981-82 recessions the distributions provide some evidence of a trend increase in cyclical sensitivity. The strength of this evidence depends on the way in which each price-change measure is adjusted for the trend in the corresponding price. Two price-trend measures were considered. In one case both CPI and ISPI price changes provided statistically significant evidence of a trend increase in cyclical sensitivity. When the second price-trend measure was employed all evidence of increasing cyclical sensitivity was eliminated for the ISPI. For the CPI some evidence persisted, but in a weakened form. Third, study of price-change distributions for groups of ISPI and CPI prices did not produce any statistically significant evidence against the hypothesis that observations one and two above are generally valid independent of product market characteristics. While certain anomalies were observed they were not statistically significant.

Some work was done to assess the effect of product market characteristics on the cyclical behaviour of prices. A portmanteau test indicated strong effects for both the CPI and the ISPI. Attempts to detect differences in cyclical behaviour between particular groups of prices were less successful. The prices of export-oriented products included in the ISPI were generally more sensitive to cycles than ISPI prices as a whole. An examination of regulated and unregulated CPI prices indicated that regulated prices were relatively insensitive to the 1981-82 downturn. Both these results were statistically significant.

Table 1

Characteristics of Price-Change Distributions: CPI - All Series

Cyclical Sensitivity Measure 1

Recession	Mean	Std. Dev.	Per cent decelerating
1953-54	3.35	10.6	40.2
1957-58	1.28	8.7	42.3
1960-61	-0.17	10.0	61.9
1974-75	9.19	18.0	22.7
1979-80	7.58	38.6	39.2
1981-82	-6.96	25.6	62.9

Cyclical Sensitivity Measure 2

Recession	Mean	Std. Dev.	Per cent decelerating
1953-54	3.44	12.5	37.1
1957-58	-2.22	13.4	50.5
1960-61	+0.21	12.6	51.5
1974-75	-0.37	24.5	37.1
1979-80	6.98	40.4	41.2
1981-82	-6.96	25.6	62.9

Table 2

Characteristics of Price-Change Distributions: ISPI - All Series

Cyclical Sensitivity Measure 1

Recession	Mean	Std. Dev.	Per cent decelerating
1960-61	0.62	9.5	55.1
1974-75	9.68	17.7	22.8
1979-80	5.32	33.5	36.7
1981-82	-6.36	13.8	70.6

Cyclical Sensitivity Measure 2

Recession	Mean	Std. Dev.	Per cent decelerating
1960-61	0.80	9.6	59.6
1974-75	-12.46	30.6	64.7
1979-80	-1.36	28.3	51.5
1981-82	-6.36	13.8	70.6

Table 3

Results of Sign Tests for Differences Between Means of Price-Change Distributions: CPI - All Series

Cyclical Sensitivity Measure 1

	1953-54	1957-58	1960-61	1974-75	1979-80	1981-82
1953-54	X	(+)	+	-	(+)	+
1957-58	(-)	X	+	-	(+)	+
1960-61	-	-	X	-	-	(+)
1974-75	+	+	+	X	+	+
1979-80	(-)	(-)	+	-	X	+
1981-82	-	-	(-)	-	-	X

Cyclical Sensitivity Measure 2

	1953-54	1957-58	1960-61	1974-75	1979-80	1981-82
1953-54	X	+	+	(-)	(-)	+
1957-58	-	X	(-)	(-)	(-)	(+)
1960-61	-	(+)	X	(-)	(-)	(+)
1974-75	(+)	(+)	(+)	X	(+)	+
1979-80	(+)	(+)	(+)	(-)	X	+
1981-82	-	(-)	(-)	-	-	X

Table 4

Results of Sign Tests for Differences Between Variances of Price-Change Distributions: CPI - All Series

Cyclical Sensitivity Measure 1

	1953-54	1957-58	1960-61	1974-75	1979-80	1981-82
1953-54	X	+	(+)	-	-	-
1957-58	-	X	(-)	-	-	-
1960-61	(-)	(+)	X	-	-	-
1974-75	+	+	+	X	(-)	(-)
1979-80	+	+	+	(+)	X	(-)
1981-82	+	+	+	(+)	(+)	X

Cyclical Sensitivity Measure 2

	1953-54	1957-58	1960-61	1974-75	1979-80	1981-82
1953-54	X	(-)	(+)	-	-	-
1957-58	(+)	X	+	-	-	(-)
1960-61	(-)	-	X	-	-	-
1974-75	+	+	+	X	(+)	(+)
1979-80	+	+	+	(-)	X	(-)
1981-82	+	(+)	+	(-)	(+)	X

Table 5

Results of Sign Tests for Differences Between Means of Price-Change Distributions: ISPI - All Series

Cyclical Sensitivity Measure 1

	1960-61	1974-75	1979-80	1981-82
1960-61	X	-	-	+
1974-75	+	X	+	+
1979-80	+	-	X	+
1981-82	-	-	-	X

Cyclical Sensitivity Measure 2

	1960-61	1974-75	1979-80	1981-82
1960-61	X	+	(-)	+
1974-75	-	X	-	(+)
1979-80	(+)	+	X	(+)
1981-82	-	(-)	(-)	X

Table 6

Results of Sign Tests for Differences Between Variances of Price-Change Distributions: ISPI - All Series

Cyclical Sensitivity Measure 1

	1960-61	1974-75	1979-80	1981-82
1960-61	X	-	-	-
1974-75	+	X	+	+
1979-80	+	-	X	(+)
1981-82	+	-	(-)	X

Cyclical Sensitivity Measure 2

	1960-61	1974-75	1979-80	1981-82
1960-61	X	-	-	-
1974-75	+	X	+	+
1979-80	+	-	X	(+)
1981-82	+	-	(-)	X

Table 7

Characteristics of Price-Change Distributions: ISPI Disaggregated by Product Market Characteristics

Cyclical Sensitivity Measure 1

Recession	Closed (53 series) Mean	Std. Dev.	Open (14 series) Mean	Std. Dev.	Import-competing (37 series) Mean	Std. Dev.	Export-oriented (27 series) Mean	Std. Dev.	Energy (5 series) Mean	Std. Dev.
1960-61	1.56	9.4	0.17	3.3	1.03	9.6	-1.45	12.1	-0.06	3.8
1974-75	13.41	17.5	4.16	16.7	13.0	13.5	0.09	21.8	8.52	2.6
1979-80	8.56	38.9	-1.34	7.1	13.32	36.3	-8.04	25.2	2.48	7.1
1981-82	-3.37	9.0	-4.67	9.2	-4.78	19.1	-11.0	11.7	-29.35	2.5

	% Decelerating	% Decelerating	% Decelerating	% Decelerating	% Decelerating
1960-61	52.8	64.2	48.6	66.7	40.0
1974-75	13.2	42.9	10.8	51.9	0.0
1979-80	32.1	42.9	29.7	55.6	20.0
1981-82	69.8	71.4	56.8	85.2	100.0

Cyclical Sensitivity Measure 2

Recession	Closed (53 series) Mean	Std. Dev.	Open (14 series) Mean	Std. Dev.	Import-competing (37 series) Mean	Std. Dev.	Export-oriented (27 series) Mean	Std. Dev.	Energy (5 series) Mean	Std. Dev.
1960-61	2.27	9.8	-0.27	3.3	-0.61	7.8	0.11	13.7	-1.69	2.5
1974-75	-5.79	30.2	-16.31	36.7	-8.98	32.6	-23.88	19.7	-36.51	30.3
1979-80	3.81	32.0	-6.57	8.6	5.39	29.8	-18.13	20.3	-9.0	10.3
1981-82	-3.37	9.0	-4.67	9.2	-4.78	19.1	-11.0	11.7	-29.35	2.5

	% Decelerating	% Decelerating	% Decelerating	% Decelerating	% Decelerating
1960-61	49.1	57.1	64.9	66.7	100.0
1974-75	56.6	50.0	56.8	92.6	100.0
1979-80	41.5	78.6	40.5	74.1	40.0
1981-82	69.8	71.4	56.8	85.2	100.0

Table 8

Spearman Rank Correlation Coefficients: ISPI

Cyclical Sensitivity Measure 1

	1960-61	1974-75	1979-80	1981-82
1960-61	1.0	.844	.829	.869
1974-75	.844	1.0	.916	.846
1979-80	.829	.916	1.0	.860
1981-82	.869	.846	.860	1.0

Cyclical Sensitivity Measure 2

	1960-61	1974-75	1979-80	1981-82
1960-61	1.0	.819	.832	.851
1974-75	.819	1.0	.884	.839
1979-80	.832	.884	1.0	.868
1981-82	.851	.839	.868	1.0

Table 9

Spearman Rank Correlation Coefficients: CPI

Cyclical Sensitivity Measure 1

	1953-54	1957-58	1960-61	1974-75	1979-80	1981-82
1953-54	1.0	.835	.866	.821	.802	.836
1957-58	.835	1.0	.828	.820	.826	.836
1960-61	.866	.828	1.0	.863	.816	.878
1974-75	.821	.820	.863	1.0	.881	.854
1979-80	.802	.826	.816	.881	1.0	.822
1981-82	.836	.836	.878	.854	.822	1.0

Cyclical Sensitivity Measure 2

	1953-54	1957-58	1960-61	1974-75	1979-80	1981-82
1953-54	1.0	.842	.869	.813	.822	.821
1957-58	.842	1.0	.819	.821	.829	.820
1960-61	.869	.819	1.0	.813	.767	.849
1974-75	.813	.821	.813	1.0	.866	.843
1979-80	.822	.829	.767	.866	1.0	.831
1981-82	.821	.820	.849	.843	.831	1.0

Table 10

Results of MW Tests for Differences Between Mean Price Changes of Various Product Groups by Recession: ISPI

Cyclical Sensitivity Measure 1

1960-61

	Im	Ex	Cl	Op	En
Import	X	(+)	(-)	(+)	(-)
Export	(-)	X	(-)	(-)	(-)
Closed	(+)	(+)	X	(+)	(+)
Open	(-)	(+)	(-)	X	(-)
Energy	(+)	(+)	(-)	(+)	X

1974-75

	Im	Ex	Cl	Op	En
Import	X	+	(+)	(+)	(+)
Export	-	X	-	(-)	(-)
Closed	(-)	+	X	(+)	(+)
Open	(-)	(+)	(-)	X	(+)
Energy	(-)	(+)	(-)	(-)	X

1979-80

	Im	Ex	Cl	Op	En
Import	X	+	(+)	+	(+)
Export	-	X	(-)	(-)	(-)
Closed	(-)	(+)	X	(+)	(+)
Open	-	(+)	(-)	X	(-)
Energy	(-)	(+)	(-)	(+)	X

1981-82

	Im	Ex	Cl	Op	En
Import	X	+	(+)	(+)	+
Export	-	X	-	(-)	+
Closed	(-)	+	X	(+)	+
Open	(-)	(+)	(-)	X	+
Energy	-	-	-	-	X

Cyclical Sensitivity Measure 2

1960-61

	Im	Ex	Cl	Op	En
Import	X	(+)	(-)	(+)	(+)
Export	(-)	X	(-)	(-)	(-)
Closed	(+)	(+)	X	(+)	(+)
Open	(-)	(+)	(-)	X	(+)
Energy	(-)	(+)	(-)	(-)	X

1974-75

	Im	Ex	Cl	Op	En
Import	X	+	(-)	(+)	+
Export	-	X	-	(-)	(+)
Closed	(+)	+	X	(+)	+
Open	(-)	(+)	(-)	X	(+)
Energy	-	(-)	-	(-)	X

1979-80

	Im	Ex	Cl	Op	En
Import	X	+	(+)	+	(+)
Export	-	X	(-)	(-)	(-)
Closed	(-)	+	X	+	(+)
Open	-	(+)	(-)	X	(-)
Energy	(-)	(+)	(-)	(+)	X

1981-82

	Im	Ex	Cl	Op	En
Import	X	+	(+)	(+)	+
Export	-	X	-	(-)	+
Closed	(-)	+	X	(+)	+
Open	(-)	(+)	(-)	X	+
Energy	-	-	-	-	X

Table 11

Results of MW Tests for Differences Between Variances of Price-Change Distributions: ISPI - Various Product Groups

Cyclical Sensitivity Measure 1

1960-61

	Im	Ex	Cl	Op	En
Import	X	-	(-)	(+)	(-)
Export	+	X	+	+	(+)
Closed	(+)	-	X	(+)	(+)
Open	(-)	-	(-)	X	(-)
Energy	(+)	(-)	(-)	(+)	X

1974-75

	Im	Ex	Cl	Op	En
Import	X	-	(-)	-	+
Export	+	X	(+)	(+)	+
Closed	(+)	(-)	X	(-)	+
Open	+	(-)	(+)	X	+
Energy	-	-	(-)	-	X

1979-80

	Im	Ex	Cl	Op	En
Import	X	(-)	(+)	+	(+)
Export	(+)	X	+	+	+
Closed	(-)	-	X	(+)	(+)
Open	-	-	(-)	X	(+)
Energy	(-)	-	(-)	(-)	X

1981-82

	Im	Ex	Cl	Op	En
Import	X	(+)	(+)	(+)	+
Export	(-)	X	(+)	(+)	+
Closed	(-)	(-)	X	(+)	+
Open	(-)	(-)	(-)	X	+
Energy	-	-	-	-	X

Cyclical Sensitivity Measure 2

1960-61

	Im	Ex	Cl	Op	En
Import	X	-	-	(-)	(-)
Export	+	X	(+)	+	(+)
Closed	+	(-)	X	(+)	(+)
Open	(+)	-	(-)	X	(+)
Energy	(+)	(-)	(-)	(-)	X

1974-75

	Im	Ex	Cl	Op	En
Import	X	+	(+)	-	(-)
Export	-	X	(-)	-	-
Closed	(-)	(+)	X	-	(-)
Open	+	+	+	X	(+)
Energy	(+)	+	(+)	(-)	X

1979-80

	Im	Ex	Cl	Op	En
Import	X	-	(+)	(+)	(+)
Export	+	X	+	+	(+)
Closed	(-)	-	X	(+)	(+)
Open	(-)	-	(-)	X	(-)
Energy	(-)	(-)	(-)	(+)	X

1981-82

	Im	Ex	Cl	Op	En
Import	X	(+)	(+)	(+)	+
Export	(-)	X	(+)	(+)	+
Closed	(-)	(-)	X	(+)	+
Open	(-)	(-)	(-)	X	+
Energy	-	-	-	-	X

Table 12

Results of Sign Tests for Differences Between Means of Price-Change Distributions: ISPI Disaggregated by Product Market Characteristics

Cyclical Sensitivity Measure 1

	Import-competing				Export-oriented			
	1960-61	1974-75	1979-80	1981-82	1960-61	1974-75	1979-80	1981-82
1960-61	X	-	-	(+)	X	(-)	(+)	(+)
1974-75	+	X	+	+	(+)	X	(+)	+
1979-80	+	-	X	+	(-)	(-)	X	(+)
1981-82	(-)	-	-	X	(-)	-	(-)	X

	Closed economy				Open economy			
	1960-61	1974-75	1979-80	1981-82	1960-61	1974-75	1979-80	1981-82
1960-61	X	-	(-)	+	X	(-)	(+)	(+)
1974-75	+	X	+	+	(+)	X	+	+
1979-80	(+)	-	X	+	(-)	-	X	+
1981-82	-	-	-	X	(-)	-	-	X

Energy

	1960-61	1974-75	1979-80	1981-82
1960-61	X	-	(-)	+
1974-75	+	X	+	+
1979-80	(+)	-	X	+
1981-82	-	-	-	X

Cyclical Sensitivity Measure 2

	Import-competing				Export-oriented			
	1960-61	1974-75	1979-80	1981-82	1960-61	1974-75	1979-80	1981-82
1960-61	X	(-)	(-)	(-)	X	+	(+)	+
1974-75	(+)	X	(-)	(-)	-	X	(-)	(-)
1979-80	(+)	(+)	X	(+)	(-)	(+)	X	(+)
1981-82	(+)	(+)	(-)	X	-	(+)	(-)	X

	Closed economy				Open economy			
	1960-61	1974-75	1979-80	1981-82	1960-61	1974-75	1979-80	1981-82
1960-61	X	(+)	(-)	+	X	X	(+)	(-)
1974-75	(-)	X	(-)	(+)	X	X	(+)	(+)
1979-80	(+)	(+)	X	+	(-)	(-)	X	X
1981-82	-	(-)	-	X	(+)	(-)	X	X

Energy

	1960-61	1974-75	1979-80	1981-82
1960-61	X	(+)	(-)	+
1974-75	(-)	X	-	+
1979-80	(+)	(+)	X	+
1981-82	-	-	-	X

Table 13

Results of Sign Tests for Differences Between Variances of Price-Change Distributions: ISPI Disaggregated by Product Market Characteristics

Cyclical Sensitivity Measure 1

	Import-competing				Export-oriented			
	1960-61	1974-75	1979-80	1981-82	1960-61	1974-75	1979-80	1981-82
1960-61	X	-	-	-	X	-	-	(-)
1974-75	+	X	(-)	(+)	+	X	-	(+)
1979-80	+	(+)	X	(+)	+	+	X	+
1981-82	+	(-)	(-)	X	(+)	(-)	-	X

	Closed economy				Open economy			
	1960-61	1974-75	1979-80	1981-82	1960-61	1974-75	1979-80	1981-82
1960-61	X	-	-	-	X	-	-	-
1974-75	+	X	(+)	+	+	X	+	+
1979-80	+	(-)	X	(+)	+	(-)	X	(+)
1981-82	+	-	(-)	X	+	(-)	(-)	X

	Energy			
	1960-61	1974-75	1979-80	1981-82
1960-61	X	(+)	(-)	(-)
1974-75	(-)	X	(+)	(+)
1979-80	(+)	(-)	X	(+)
1981-82	(+)	(-)	(-)	X

Cyclical Sensitivity Measure 2

	Import-competing				Export-oriented			
	1960-61	1974-75	1979-80	1981-82	1960-61	1974-75	1979-80	1981-82
1960-61	X	-	-	-	X	(-)	(-)	(+)
1974-75	+	X	+	+	(+)	X	(-)	(+)
1979-80	+	-	X	(+)	(+)	(+)	X	+
1981-82	+	-	(-)	X	(-)	(-)	-	X

	Closed economy				Open economy			
	1960-61	1974-75	1979-80	1981-82	1960-61	1974-75	1979-80	1981-82
1960-61	X	-	(-)	(-)	X	-	(-)	(+)
1974-75	+	X	+	+	+	X	+	+
1979-80	(+)	-	X	(+)	(+)	-	X	(+)
1981-82	(+)	-	(-)	X	(-)	-	(-)	X

	Energy			
	1960-61	1974-75	1979-80	1981-82
1960-61	X	-	(-)	(-)
1974-75	+	X	(+)	+
1979-80	(+)	(-)	X	(+)
1981-82	(+)	-	(-)	X

Table 14

Characteristics of Price-Change Distributions: CPI by Product Market Characteristics

Cyclical Sensitivity Measure 1

Recession	Import-competing (23 series) Mean	Import-competing (23 series) Std. Dev.	Other (74 series) Mean	Other (74 series) Std. Dev.
1953-54	5.36	11.6	2.72	10.3
1957-58	-2.13	14.0	2.34	6.0
1960-61	-0.94	9.3	-0.07	10.2
1974-75	12.48	15.1	8.17	18.8
1979-80	6.94	34.5	8.03	39.9
1981-82	-5.84	25.1	-7.31	25.9

	% Decelerating	% Decelerating
1953-54	30.4	43.2
1957-58	47.8	40.5
1960-61	56.5	63.5
1974-75	17.4	24.3
1979-80	26.1	43.2
1981-82	65.2	62.2

Cyclical Sensitivity Measure 2

	Mean	Std. Dev.	Mean	Std. Dev.
1953-54	5.01	14.5	2.95	11.9
1957-58	-6.82	18.6	-0.79	11.1
1960-61	-3.16	9.8	1.26	13.2
1974-75	2.77	23.7	-1.35	24.8
1979-80	5.31	40.2	7.50	40.7
1981-82	-5.84	25.1	-7.31	25.9

	% Decelerating	% Decelerating
1953-54	30.4	39.2
1957-58	65.2	45.9
1960-61	60.9	48.6
1974-75	30.4	39.2
1979-80	43.5	40.5
1981-82	65.2	62.2

Table 15

Characteristics of Price-Change Distributions: CPI by Government Regulation

Cyclical Sensitivity Measure 1

Recession	Regulated (21 series) Mean	Regulated (21 series) Std. Dev.	Unregulated (76 series) Mean	Unregulated (76 series) Std. Dev.
1974-75	7.67	10.3	9.61	19.7
1979-80	0.30	8.7	9.83	43.1
1981-82	1.02	15.6	-9.17	27.4

	% Decelerating	% Decelerating
1974-75	19.0	23.7
1979-80	42.9	38.2
1981-82	42.9	68.4

Cyclical Sensitivity Measure 2

	Mean	Std. Dev.	Mean	Std. Dev.
1974-75	0.57	13.0	-0.63	26.9
1979-80	0.67	10.2	8.73	45.2
1981-82	1.02	15.6	-9.17	27.4

	% Decelerating	% Decelerating
1974-75	28.6	39.5
1979-80	28.6	44.7
1981-82	42.9	68.4

FIGURE 1

Example Cumulative Density Function

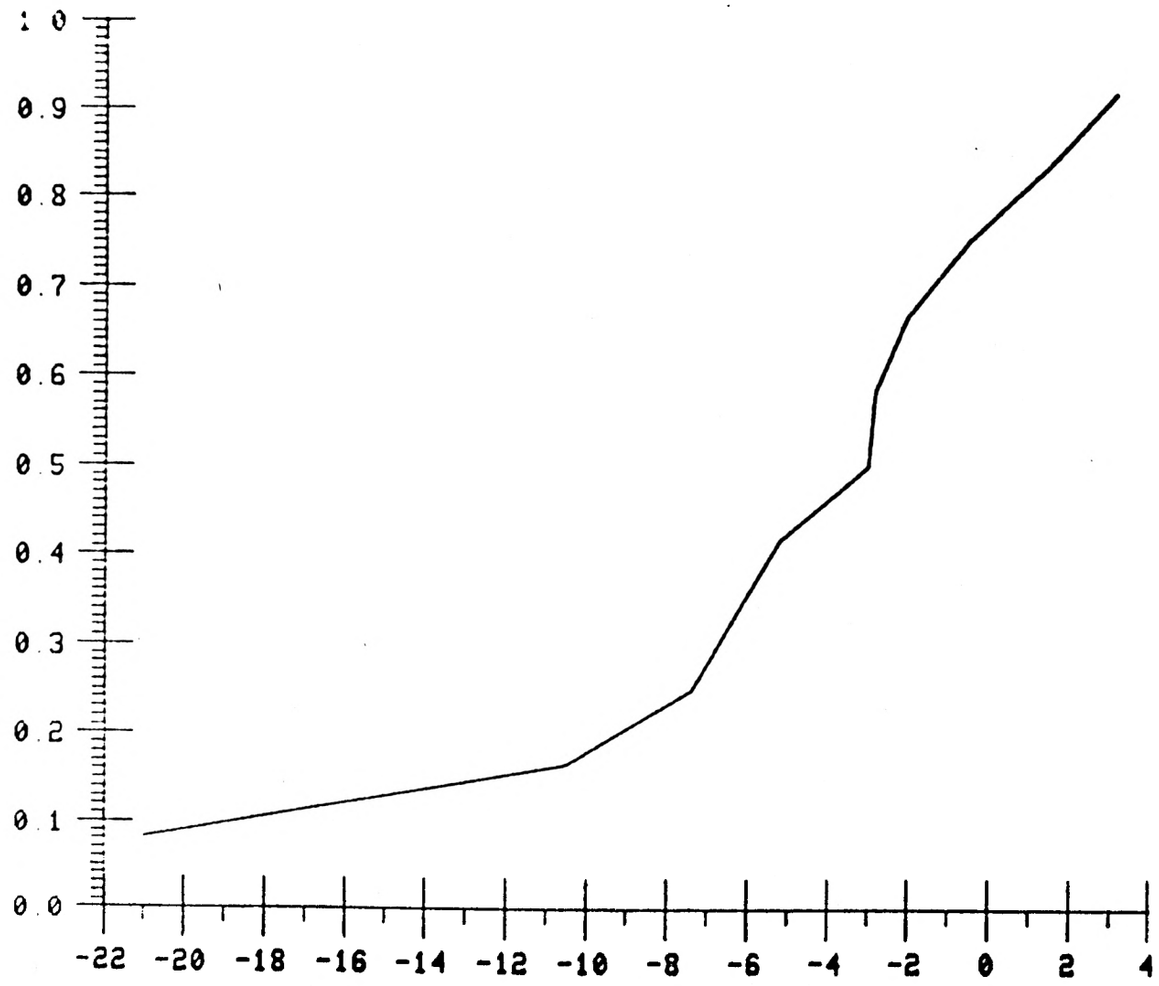


Figure 2A

CPI Cumulative Density Functions of Price Changes
Cyclical Sensitivity Measure 1

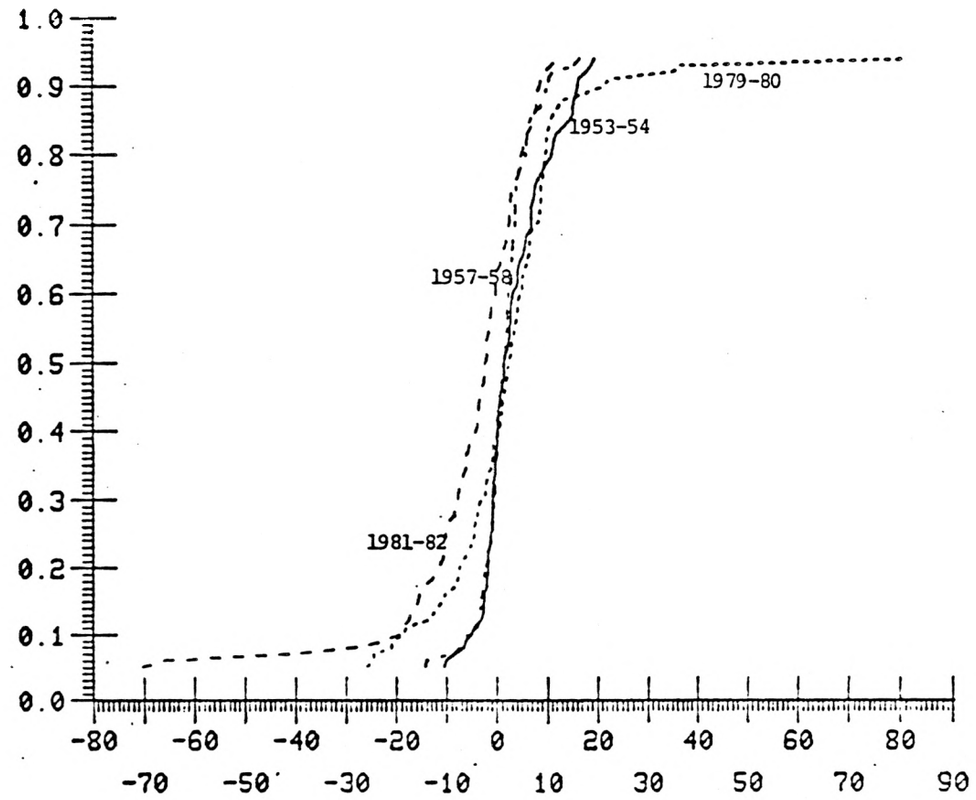


Figure 2B

CPI Cumulative Density Functions of Price Changes
Cyclical Sensitivity Measure 2

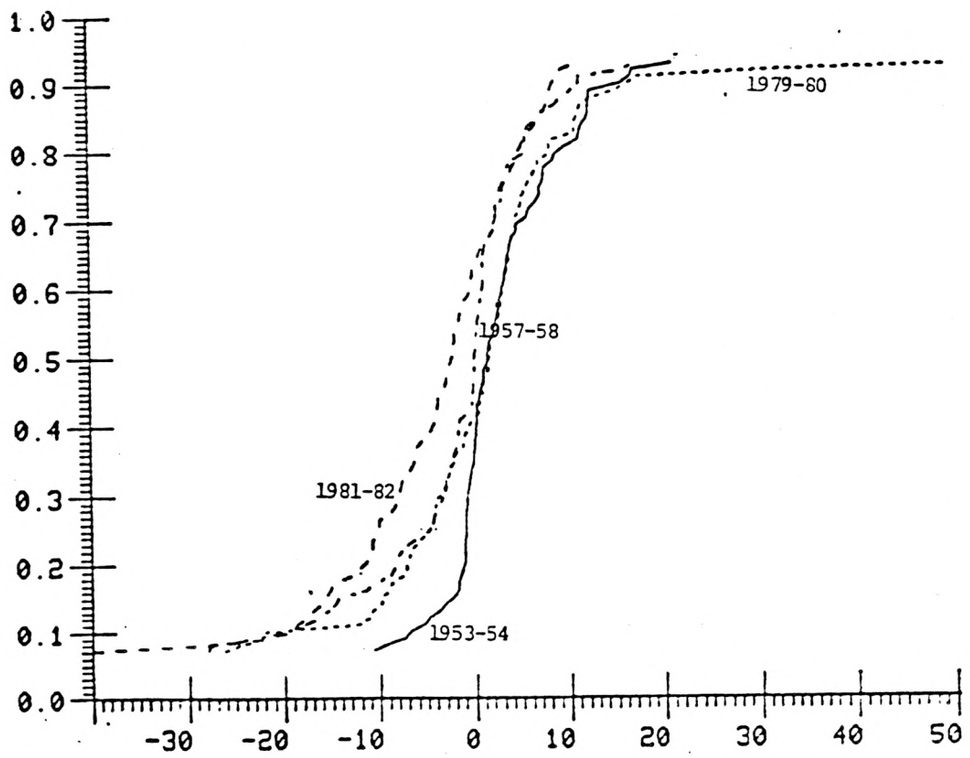


Figure 2C

CPI Cumulative Density Functions of Price Changes
Cyclical Sensitivity Measure 1

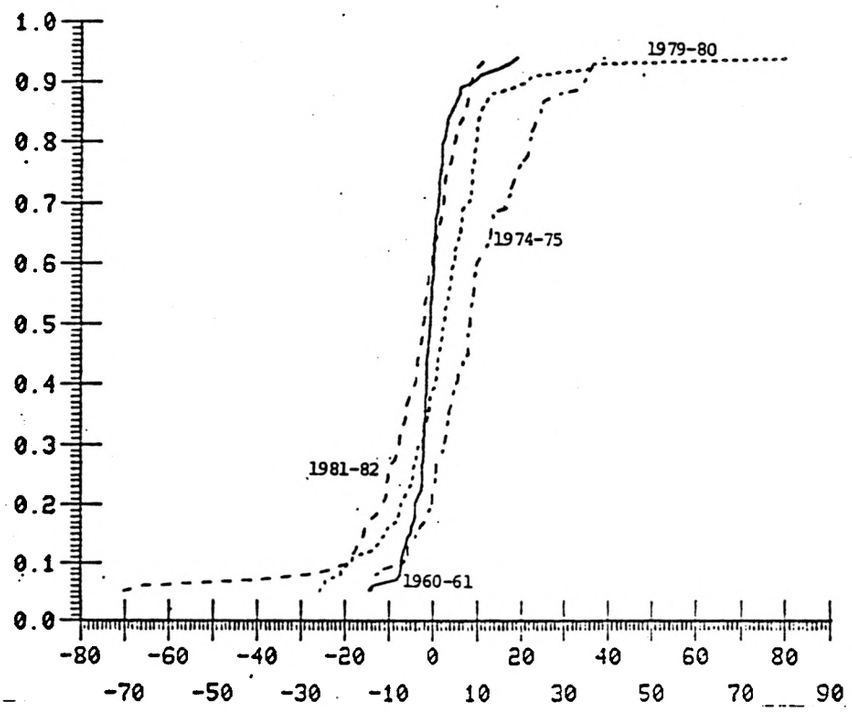


Figure 2D

CPI Cumulative Density Functions of Price Changes
Cyclical Sensitivity Measure 2

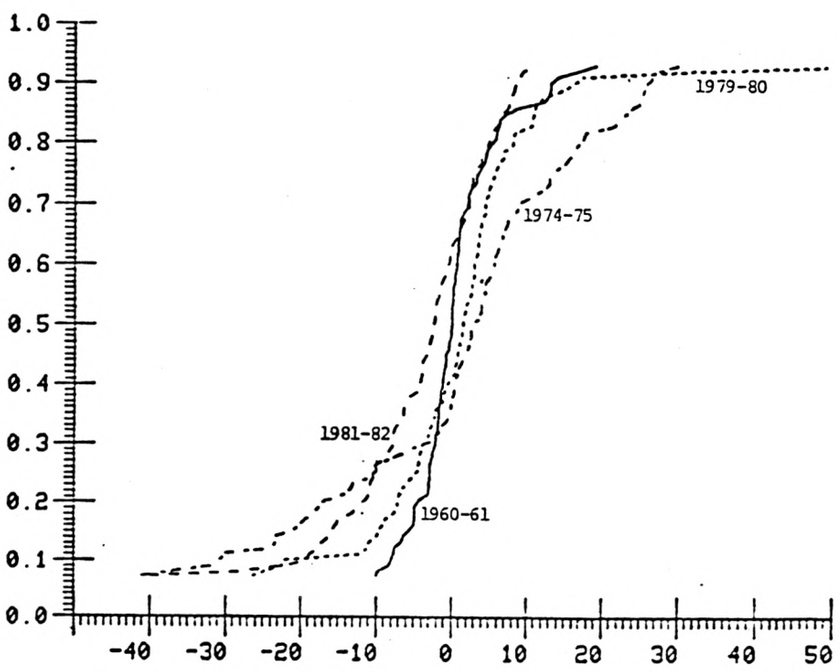


Figure 3A

ISPI Cumulative Density Functions of Price Changes
Cyclical Sensitivity Measure 1

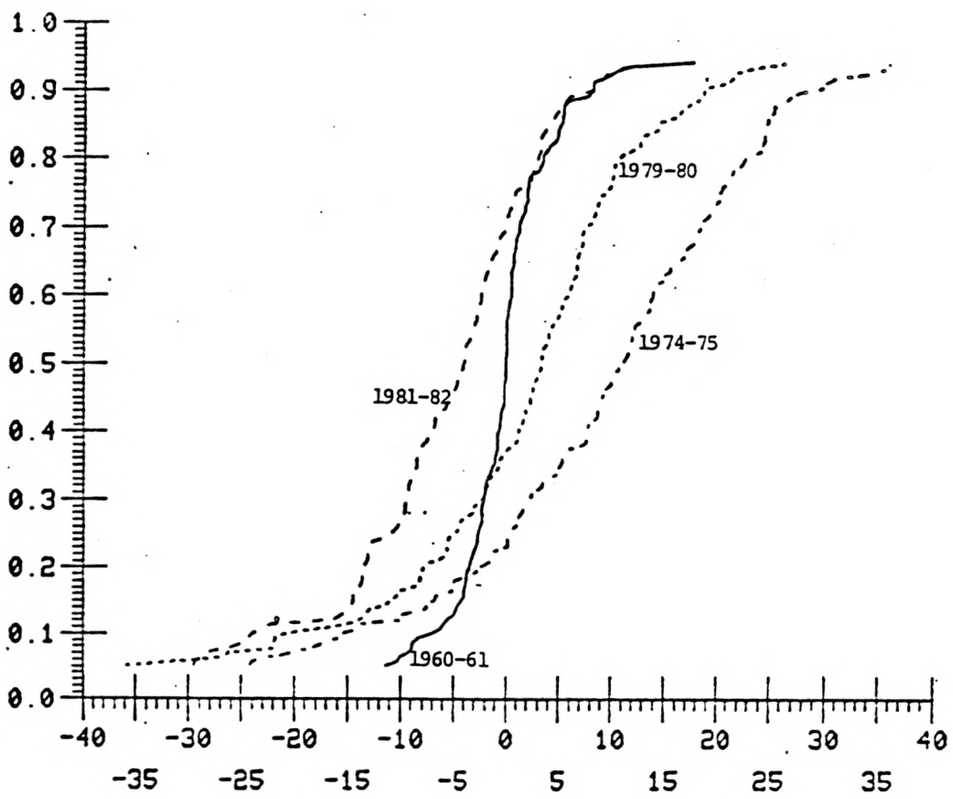
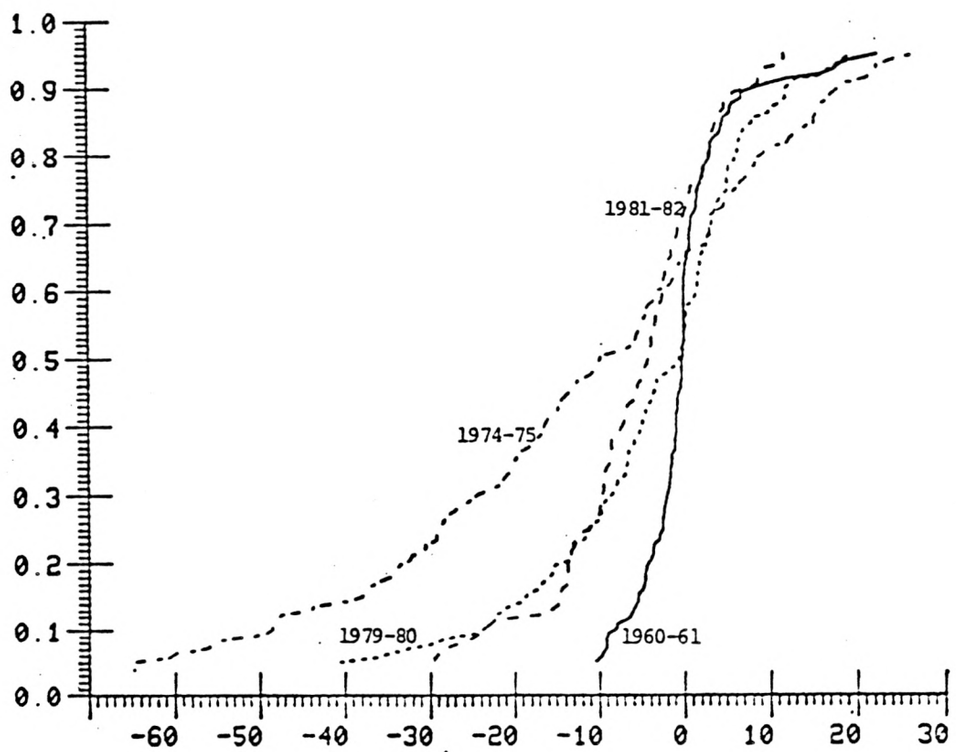


Figure 3B

ISPI Cumulative Density Functions of Price Changes
Cyclical Sensitivity Measure 2



APPENDIX 1
Methodology for Classification of CPI and ISPI Prices

The ISPI series chosen by the selection procedure described in section 2 were divided into groups on the basis of product market characteristics following a classification system developed by Clinton and Hannah [6]. This classification procedure was applied at the two-digit level. The series at a lower level of aggregation used in this study were usually classified according to the classification of the corresponding two-digit aggregate. In certain cases I used a different classification based on additional information from Statistics Canada (Statistics Canada, [8]).

The Clinton and Hannah system is based on measures, for each two-digit industry, of export orientation (the value of exports divided by total shipments) and import penetration (imports divided by the size of the Canadian market). Industries with export measures greater than 20% and import measures less than 20% were classified as export-oriented. Those with export measures less than 20% and import measures greater than 20% were considered import-competing. Industries with both import and export measures greater than 20% were placed in the open category and those with both measures less than 20% were classified as closed.

In order to select a set of prices of import-competing products from the 97 Consumer Price Index series used in section 2, sub-aggregate commodity data from input-output tables supplied by Statistics Canada were examined. An input-output commodity was designated as import-competing if the ratio of imports to total domestic commercial demand was greater than 25%. A reconciliation of the input-output commodities and the 1974 Family Expenditure Survey commodity breakdown was made available by Statistics Canada. FES items were then matched with CPI components. When the CPI data used were at a lower level of aggregation than the FES commodity list, the product was generally classified according to the classification of the corresponding FES aggregate. In cases where the correspondence of input-output, FES and CPI commodities was not exact, other Statistics Canada information ([8]) was consulted. The division of the set of 97 CPI prices into regulated and unregulated groups was based on work by Wilson [9].

Details of the Classifications

The two-digit classification of the ISPI used for the division of the ISPI series into groups is given below.

Import-competing:
leather, textiles, knitting mills, electrical products, rubber and plastic products, miscellaneous manufacturing

Export-oriented:
primary metal industries, wood industries, paper and allied products

Open:
machinery industries, transportation equipment industries, chemical and chemical products industries

Closed:
clothing, food and beverages, tobacco products, furniture and fixtures, metal fabricating, non-metallic mineral products

Energy:
petroleum and coal refining

The import-competing and regulated groups of CPI prices were selected according to the sub-aggregate classifications given below.

Import-competing CPI:
fish, fresh fruit, fresh vegetables, sugar, household textiles and related plastics, piece-goods and notions, automobile and truck purchases, automobile batteries, bicycle purchases and operation, reading, liquor purchased from stores, vacuum cleaners

Regulated CPI:
public transportation, communications, dairy products and eggs, turkeys, vehicle registration fees and driver's licenses, water, property taxes and special charges, electricity, fuel oil and other liquid fuel, gasoline, piped and bottled gas, oil and oil change, chickens, tobacco and alcohol

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