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WP/94/35

INTERNATIONAL MONETARY FUND

Statistics Department

Drift in Producer Price Indexes for the Former Soviet Union (FSU) Countries

Prepared by François Lequiller and Kimberly D. Zieschang ^{1/}

Authorized for Distribution by Chandrakant A. Patel

March 1994

Abstract

The purpose of this paper is to show that, under the price fluctuations that characterize most transition economies, the commonly used chain index derived from the published month-to-month price change of the PPI in some cases dramatically overstates the rate of price inflation. The analysis is based in part on a seminal paper by Szulc, who studies the problem of drift for a wide class of index formulae, and in part on the observations of price movements made by the Fund's missions. Greatest during the year 1992, the drift declines with slower rates of inflation and, possibly, with changing patterns of price increases, but is still important for countries such as Russia, where monthly inflation continues to run well into the double digits.

JEL Classification Numbers:

C43, C82, E31

^{1/} The authors would like to thank V. Koen, D. Citrin, and M. Dieckman of the Fund's European II Department; R. Dippelsman and P. Cotterell of the Fund's Statistics Department; and Ralph Turvey, London School of Economics, for their useful discussion and comment.

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b. Szulc's argument

To specialize Szulc's notation somewhat for the purpose of this paper, let

$$\begin{aligned} r_i^t &= \frac{p_i^t}{p_i^{t-1}} \\ q_i^t &= \frac{q_i^{t-1}}{q_i^t} \\ c_i^{t-1} &= \frac{p_i^{t-1}}{p_i^0} \end{aligned} \quad (5)$$

In the language of practitioners, the first item is the "short-term price relative," the second is the "long-term quantity relative," and the last is the "cost weight."

The chain form of the Laspeyres index in equation (4) can then be expressed as:

$$P_L^{0,t} = \prod_{i=1}^n \frac{\sum_{i=1}^n c_i^t r_i^t}{\sum_{i=1}^n c_i^t}$$

For comparative purposes, one may select any chain index (including the WAPR/generalized Sauerbeck) with period-to-period links that can be as an average of short-term price relatives and assume that the weight is revised and a new link is introduced every period. In this case (if minor algebraic steps are omitted) the chain index can be expressed of the cost weights of the Laspeyres index as:

$$F_C^{0,t} = \prod_{\tau=1}^t \frac{\sum_{i=1}^n c_i^{\tau} r_i^{\tau} y_i^{\tau}}{\sum_{i=1}^n c_i^{\tau} y_i^{\tau}}$$

Szulc defines the cumulative drift of the chain series in "direct" Laspeyres counterpart as the ratio of (7) to (6) and theorem of Bortkiewicz to show that the drift can be written

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Summary

Economists working with price data for the countries of the former Soviet Union have frequently noted the striking difference between the cumulative price increase derived by chaining the reported monthly Producer Price Index (PPI) and the increase over 12 months as reported in the "same month of previous year" version of the same index.

This paper shows that this difference arises from the use of a non-standard formula that, under the price fluctuations that characterize most transition economies, leads the cumulative price increase derived by chaining the reported monthly PPI to overstate dramatically the rate of price inflation in most of the countries of the former Soviet Union. Although the main focus is on the PPI, it is noted that the problem could also exist for the Consumer Price Index when this index is compiled with the same nonstandard formula.

The analysis is based in part on a seminal paper by Bohdan Szulc, which studies the problem of drift for a wide class of index formulae, and in part on the observations of price movements made by Fund missions. Greatest during the year 1992, the upward drift declines with slower rates of inflation and, possibly, with changing patterns of price increases, but it is still important for countries such as Russia, where monthly inflation continues to run well into the double digits.

The paper concludes that the chained version of the PPI should not be used as a measure of producer price change and that economists should rather use other deflators or figures based on quantities or volume of production to derive constant price indicators for the countries of the former Soviet Union.

I. Introduction

Economists who have worked with Former Soviet Union (FSU) price data have noted the striking difference between the cumulative price increase derived by chaining the reported monthly Producer Price Index (PPI) 1/ and the reported change of this index over 12 months 2/.

The purpose of this paper is to show that, in the context of the price fluctuations characterizing most transition economies, a chain index derived from the month-to-month price change of the PPI dramatically overstates the rate of price inflation in some cases. The analysis is based in part on a seminal paper by Szulc, 3/ who studied the problem of drift for a wide class of index formulae, and in part on observations made by the Fund's technical assistance missions on price statistics of detailed price movements in the FSU countries. Greatest during the year 1992, the drift declines with slower rates of inflation (and possibly with changing patterns of price increases) but remains important for countries, such as Russia, in which monthly inflation continues to run well into the double digits. 4/

Consequently, the current version of the PPI should not be used as a deflator of the value of production to obtain a volume indicator. Indexes of industrial production so derived would largely underestimate the growth (or overestimate the decline) in output. As the bias under discussion is measured in relation to the Laspeyres standard, the overestimation of price change would be effectively eliminated if the basis for calculation of the PPI were changed to a Laspeyres formula.

The paper also provides an explanation for the difference between the chained monthly index and the t/t-12 version of the PPI and guidance on which of these indices should be used.

1/ The PPI is often referred to as the Wholesale Price Index (WPI) or, in Russian, as *optoviy*. This nomenclature is misleading as the observed prices are, in fact, producer prices (ex-factory gate) and not wholesale prices.

2/ See, among others, the two papers by Vincent Koen and Steven Phillips on price liberalization in Russia: IMF Working Paper 92, 1992, and IMF Occasional Paper 104, June 1993.

3/ See Szulc (1983).

4/ It should be noted that the problem with the Producer Price Index formula that is the subject of this paper also exists, in some instances, for the Consumer Price Index (CPI). Correction of this problem with the CPI should therefore be undertaken wherever it is encountered with countries of the FSU. However, the problem may not be limited to transition economies. An interesting instance of similar linking problems seems to have occurred at low levels of aggregation in the U.S. CPI, although with less serious consequences (see Moulton (1993)).

II. Background

If the fixed-base Laspeyres index is selected as the standard for comparison, the use of a certain nonstandard chained formula leads to excessive drift in measured price change.

1. A Nonstandard Formula

Fund economists have been aware for some time that the formula used to compile the PPI in FSU countries is not the Laspeyres formula used in most countries. ^{1/} Because producer price indicators were used to monitor a central economic plan, a time series with a fixed reference base was of less interest to users of the data than a set of indicators comparing prices in the current month with those of the previous month, and those of the current month with those of same month in the previous year. These specialized comparisons were formed by averaging the price relatives appropriate for the time period under consideration with a set of weights from a fixed reference period. To form a fixed reference base series from the monthly data compiled in this fashion, it was necessary to chain the monthly indices together. If the index formula implied by this practice is examined, it can be seen as a slight generalization of the Sauerbeck index studied by Szulc (1983), and it might therefore be called "the generalized Sauerbeck index." ^{2/}

a. The Sauerbeck Index Versus the Laspeyres Index

The generalized Sauerbeck, or Weighted Average of Price Relatives (WAPR), index formula used in the wholesale price indexes of a number of FSU countries is:

$$P_{WAPR}^{0,t} = \prod_{\tau=1}^t \sum_{i=1}^n w_i^0 \frac{p_i^{\tau}}{p_i^{\tau-1}} \quad (1)$$

In this formula, the i subscript indexes item, the t superscript indexes time period (month), the 0 superscript represents the base period, p represents price, and w represents the item weight from the base period. For each item i , w is computed as:

^{1/} This fact is not necessarily well known outside the Fund, however. The recent OECD publication entitled Short-term Economic Indicators for Central and Eastern Europe: Sources and Definitions incorrectly attributed a Laspeyres methodology to the Estonian PPI.

^{2/} Szulc refers to a chain of unweighted averages of price relatives for adjacent pairs of time periods as "the Sauerbeck formula." The formula used in FSU countries is a chain of weighted averages in which the weights remain constant from period to period—hence the term "generalized Sauerbeck."

$$w_i^0 = \frac{p_i^0 q_i^0}{\sum_{i=1}^n p_i^0 q_i^0} \quad (2)$$

From the formula, it can be seen that this is a chain of fixed-weighted averages of short-term price relatives.

The Laspeyres index formula is

$$p_{L,t}^0 = \frac{\sum_{i=1}^n p_i^t q_i^0}{\sum_{i=1}^n p_i^0 q_i^0} = \sum_{i=1}^n \left[w_i^0 \frac{p_i^{t-1}}{p_i^0} \right] \frac{p_i^t}{p_i^{t-1}} \quad (3)$$

$$= \prod_{\tau=1}^t \sum_{i=1}^n \left[\frac{w_i^0 \frac{p_i^{\tau-1}}{p_i^0}}{\sum_{i=1}^n w_i^0 \frac{p_i^{\tau-1}}{p_i^0}} \right] \frac{p_i^\tau}{p_i^{\tau-1}} \quad (4)$$

which, as shown, can be also be expressed as a chain of averages of short-term price relatives, but in contrast with equation (1), with weights that vary from period to period. The formulas in equations (1) and (4) look deceptively similar and, by inspection, are in fact identical for the first time period following the base when $t = 1$.

A comparison of the Laspeyres and Sauerbeck formulas shows that negative serial correlation, under which the relatives assume higher than average values that are followed by lower than average values and vice versa, induces an upward bias in the Sauerbeck formula. Such negative correlation is a rather common occurrence in transition economies. Positive correlation, which is characterized by more uniform price changes across commodities, results in a downward drift in the Sauerbeck.

b. Szulc's argument

To specialize Szulc's notation somewhat for the purpose of this paper, let

$$\begin{aligned} r_i^t &= \frac{p_i^t}{p_i^{t-1}} \\ y_i^t &= \frac{q_i^{t-1}}{q_i^0} \\ c_i^t &= \frac{p_i^{t-1}}{p_i^0} \end{aligned} \quad (5)$$

In the language of practitioners, the first item is the "short-term price relative," the second is the "long-term quantity relative," and the last is the "cost weight."

The chain form of the Laspeyres index in equation (4) can then be expressed as:

$$P_{L,t}^{0,t} = \prod_{\tau=1}^t \frac{\sum_{i=1}^n c_i^{\tau} r_i^{\tau}}{\sum_{i=1}^n c_i^{\tau}} \quad (6)$$

For comparative purposes, one may select any chain index (including the WAPR/generalized Sauerbeck) with period-to-period links that can be expressed as an average of short-term price relatives and assume that the weights are revised and a new link is introduced every period. In this case (if several minor algebraic steps are omitted) the chain index can be expressed in terms of the cost weights of the Laspeyres index as:

$$P_{C,t}^{0,t} = \prod_{\tau=1}^t \frac{\sum_{i=1}^n c_i^{\tau} r_i^{\tau} y_i^{\tau}}{\sum_{i=1}^n c_i^{\tau} y_i^{\tau}} \quad (7)$$

Szulc defines the cumulative drift of the chain series in relation to its "direct" Laspeyres counterpart as the ratio of (7) to (6) and applies a theorem of Bortkiewicz to show that the drift can be written as:

$$D^{0,t} = \prod_{\tau=1}^t \frac{\sum_{i=1}^n c_i^{\tau} r_i^{\tau} y_i^{\tau} / \sum_{i=1}^n c_i^{\tau} y_i^{\tau}}{\sum_{i=1}^n c_i^{\tau} r_i^{\tau} / \sum_{i=1}^n c_i^{\tau}}$$

$$= \prod_{\tau=1}^t (1 + \text{corr}(r^{\tau}, y^{\tau}) \text{cv}(r^{\tau}) \text{cv}(y^{\tau})) \quad (8)$$

In equation (8), $\text{corr}(r, y)$ refers to the correlation between r and y , and $\text{cv}(r)$ and $\text{cv}(y)$ refer to the coefficients of variation of r and y . (The cv is the ratio of the standard deviation to the mean.) Equation (8) is Szulc's central result and elegantly decomposes drift into its component factors. In each period, both the direction and magnitude of drift critically depend on the (cost-weighted) correlation across items between the short-term price relatives (r) and the long-term quantity relatives (y). From the term in equation (8) that depends on (cost-weighted) coefficients of variation (cvs), it can be inferred that highly variable and negatively correlated price and quantity movements across items for a given time period (because these effects increase the cvs of r and y) also increase the magnitude of drift, but do not affect its direction.

Drift in the Sauerbeck index may now be analyzed. In any specified period t , the "quantity weights" of the WAPR/generalized Sauerbeck index are proportional to the base period share weight divided by the price of the previous period, as the following equation shows:

$$q_{\text{WAPR}, i}^{t-1} \propto \frac{w_i^0}{p_i^{t-1}} \quad (9)$$

The long-term quantity relative (y) for each item (i) (which is the above quantity expression divided by the fixed quantity level for that item in the base period) is proportional to the reciprocal of the price (p) of the previous period, and, by inspection, so is the short-term price relative (r). Since r and y share a common factor, a strong case can be made that they will be positively correlated across items in most situations and that, in comparison with the Laspeyres, the WAPR will drift upward. ^{1/} For the WAPR, positive correlation between r and y is implied by negative serial correlation in the short-term price relatives. Similarly, a negative correlation between

^{1/} Szulc points out that the Sauerbeck is consistent with the assumption of very strong substitution effects. From equation (9), it may be seen that this is also true of the generalized Sauerbeck/WAPR index. The correlation between percentage changes in p and q from the same time period for the same item is clearly -1.

r and y is implied by a positive serial correlation in the short-term price relatives. 1/ Drift will be exacerbated by high own-variability and negative contemporaneous correlation between price relatives (r) across items, because these two effects will increase the coefficient of variation in both r and y for the WAPR formula.

2. Relevance to the Context of Former Soviet Union Countries

Positive serial correlation in price relatives is typical of market economies in a steady state: all prices move more or less together and with small variations in rates of change over time. Strong negative serial correlation in the relatives and high variability in rates of change across items is typical both of market economies encountering unanticipated sectoral shocks, and transition economies. In the latter case, price movements are characterized by price "liberalization" in fits and starts, sector by sector, as the government resets prices according to evolving notions of their equilibrium levels and political feasibility. Under these conditions, monthly price relatives for selected classes of goods typically follow a pattern of assuming a value of unity, then a value substantially greater than unity, then unity again. Since higher-than-average values succeed lower-than-average values, this form of price adjustment produces negative serial correlations in the monthly relatives.

The potential for bias resulting from use of the Sauerbeck formula is dramatically illustrated by Szulc's "bouncing" price relatives example. 2/

1/ This relationship between serial correlation in r and contemporaneous correlation between r and y may not be obvious from equations (8) and (9). Since

$$p_i^{t-1} = p_i^0 \prod_{\tau=1}^{t-1} r_i^{\tau}$$

it may be argued that, for the WAPR, the correlation between r and y becomes a function of the correlations between r in the current period and its reciprocal from previous periods back to the base. If the short-term relatives are positively serially correlated, the correlation between r in the current period and the product of its past values would be positive. By implication, the correlation of current period r with *the reciprocal* of the product of its past values would be negative. The correlation between r and y will therefore be negative for the WAPR formula when the short-term relatives are positively serially correlated, and the WAPR will display downward drift in comparison with the Laspeyres. If the same reasoning is used, it may be argued that negative serial correlation in r will induce upward drift.

2/ The example uses the Sauerbeck formula and thus equally weights the price relatives in constructing each chain link.