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Methodologies of Price Indices in Transition Countries 1/

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Abstract

Since late 1991, the IMF Statistics Department has conducted a program of technical assistance on consumer and producer price measurement and index compilation for the countries that have emerged from the former Soviet Union. These are countries whose economies are in various states of transition from centrally planned to market organization, and face special difficulties in developing price indices meeting international methodological guidelines for use in setting and monitoring the progress of macroeconomic policy. This paper describes and summarizes the findings of this technical assistance work with transition economies over the past four years, and the methodology developed by Fund experts to adapt international guidelines to the prevailing economic conditions. The paper catalogs the measurement problems and issues for compiling consumer and producer price indices in the transition context, and also comments on the use of these price series in compiling constant price national accounts.

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1/ The views expressed in this paper are those of the author and do not necessarily represent those of the Fund.

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Summary

A country's consumer and producer price indices are important indicators for setting and monitoring the progress of macroeconomic policy. Since late 1991, the IMF Statistics Department has conducted a program of technical assistance on consumer and producer price measurement and index compilation for the Baltic countries, the Russian Federation, and the former Soviet Union countries. These economies are in various states of transition from centrally planned to market organization, and face special difficulties in developing price indices that meet international methodological guidelines.

This paper describes and summarizes the findings of this technical assistance work over the past four years, and the methodology developed by Fund experts to adapt international guidelines to the prevailing economic conditions. The measurement problems and issues involved in compiling consumer and producer price indices in the transition context are cataloged, and the uses of these price series in compiling constant price national accounts are discussed.

I. Introduction

Price indices for household consumption, producer output and input, and external trade are critical indicators for monitoring the health and progress of market economies, and are closely watched in the formulation, implementation, and evaluation of monetary and fiscal policy. These series are used not only as indicators in their own right, but also as deflators to produce important derivative macroeconomic statistics such as volume series from current price national accounts data. The International Monetary Fund, in exercising surveillance over the policies of its member countries, makes extensive use of price indices and the statistics produced with them in following economic developments, and therefore has a strong interest in the accuracy of these data series. 1/ With the recent expansion of the international community to include the Baltic countries, the Russian Federation, and the other countries of the former Soviet Union, the technical assistance attention and resources of international organizations, including the IMF, have been focussed on evaluating and, as needed, upgrading the basic economic data produced by the statistical authorities of these countries to international standards for methodology, coverage, and presentation. Accordingly, in addition to its ongoing work in the development of money and banking, balance of payments, and government finance statistics in the Baltic countries, the Russian Federation and the other FSU countries, the Fund became the focal point agency for the provision of technical assistance to these countries on compilation of consumer price indices (CPIs) among international organizations in 1992, and has more recently undertaken a program of assistance on producer price indices (PPIs).

As a result of the experience of Fund technical assistance in consumer and producer indices over the past three years, standard approaches to the methodological design and organization of work for compilation of each of these important indicators have emerged, tailored to the circumstances of the transition economies of the Baltic countries, the Russian Federation and the other FSU countries. This paper describes these standard methodologies for the CPI and PPI. A review of the price statistics in place prior to the dissolution of the U.S.S.R. is followed by an overview of IMF technical assistance to date among the fifteen succeeding republics. Compilation methodology is then taken up in terms common to both the CPI and PPI. This part of the paper begins with the selection of the price index formula and the overall arrangement of its calculation. Sources and methods for estimating item weights are then discussed, followed by a section on classification, item selection, the selection of reporting establishments, and the selection of commodity varieties for pricing. Price collection and related topics are then addressed, including reporting

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1/ In this regard, see, for example, Vincent Koen and Stephen Phillips, "Price Liberalization in Russia: The Early Record," IMF Working Paper WP/92/92, November 1992.

arrangements, seasonal goods, variety substitution, introduction of new varieties, and quality adjustment. The last section on compilation methodology deals with additional issues, such as the degree of decentralization in the organization of work, specific to each type of index within the context of the Baltic countries, the Russian Federation and the other FSU countries.

Price indices are shaped in no small measure by the requirements of their ultimate uses. Important, and arguably paramount, among these uses is the deflation of the national accounts. Although progress has been made in the compilation of current price national accounts in the Baltic countries the Russian Federation, and the other FSU countries, with the assistance of the OECD and the Fund, much remains to be done in developing volume measures for value added by industry and final expenditure by institutional sector. As measures of the volume of economic activity are critical to the Fund's surveillance work and program operations, the consumer and producer price indices developed through the Fund's program of technical assistance can and should be used, among other things, for deflation of national accounts aggregates, where appropriate, to produce GDP at constant prices. Accordingly, the paper includes a section on the use of price series from the CPI and PPI compilation systems for construction of constant price national accounts series.

II. Price Statistics in the U.S.S.R.

The Retail Price Index (RPI) was the principal consumer price measure in the U.S.S.R., and survived as the principal price measure in a number of the countries that emerged with the dissolution of the union in 1991.

Prior to the transition period, all of the republics in the U.S.S.R. had similar statistical systems, including classification structures, sources of data, collection and calculation methodology, and presentation of results. The retail price index was compiled with administrative data collected from state-owned retail outlets on the current-month value of deliveries of goods and their prices, and assembled at very high levels of detail, with 1000-1500 items included. A near census of retail trade was achieved with these "samples." As current value weights were collected, it was possible to compute monthly Paasche-type indices on a timely basis, and

this formula was almost universally used. 1/ The price data were, and to a large extent still are, presented in the form of percentage change from the previous month, and from the same month of the previous year, rather as than an index series normalized to a fixed reference base. As the RPI was not published as an index relative to a fixed reference period, a standard practice to construct such a series among non-Soviet/non-FSU policy users of RPI data was to link monthly indices constructed from published percentage change data together.

The Wholesale Price Index (WPI), in the U.S.S.R. was, and remains in a number of the countries succeeding it, approximately a producer price index, because its coverage was not defined by wholesale trade, but by the value of production, generally at prices that excluded taxes and added transport margins. On the other hand, the WPI was not exactly the PPI compiled in market economies, because those indices are based on sales valued at the factory gate. The difference between sales and production is changes in inventories or stocks, and hence the principal difference between the international standard PPI concept and that of the U.S.S.R. WPI was in the construction of the weights, and in the WPI's Paasche formula rather than the internationally more common Laspeyres. The WPI was assembled from indices calculated for about 800 items, based on administrative "samples" covering about 5000 products.

The concerns with these existing producer price measures parallel the problems identified in consumer price measurement. There are insufficient methodological controls ensuring that only the prices of items with identical functional specifications are compared from month to month, the index formula used for compilation is non-standard and subject to potentially large upward biases, 2/ there is a need to insure that newly emerging private enterprises are included in the sample for pricing, the index weights are generally in need of revision given the rapid structural changes that are occurring, and the presentation of data excludes

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1/ However, the use of the Paasche formula and the practice of presenting percentage changes from the previous month and same month of the previous year tended to cause confusion among external policy users of the index. In general, these users were and are interested in both levels and rates of change in the index. Because the monthly indexes are not transitive over the year, a chain of twelve monthly Paasche price indexes ending in the current month does not generally equal the Paasche index for the current month against the same month of the previous year, and, can produce substantial drift by contrast with the direct index for the full year. This problem will be discussed in further detail in subsequent sections.

Also, these indices are not true Paasche indices. They simply weight the current month change or the twelve month change by current expenditure shares. A true Paasche index would use a harmonic mean (reciprocal) formula when the weights used are current period expenditure shares.

2/ See Annex 4 for further details.

publication of index levels relative to a fixed reference base. The number of items in the WPIs of the Baltic countries, the Russian Federation, and the other FSU countries ranges from about 300 to about 500, according to the size and complexity of the economy. Unlike the practice in consumer price measurement, this level of detail is roughly consistent with PPIs in other parts of the world. 1/

A further, special problem arises in producer price measurement that is closely related to the explosive growth in inter-enterprise arrears over the past two years. It is believed that the sales price recorded in enterprise accounts and reported for inclusion in the WPI includes a finance charge for the expected duration the enterprise will hold a receivable in connection with the sale, and also includes a component for expected inflation over the period. Normal price measurement methodology attempts to control for the conditions of sale by including them in the detailed item specifications in the index. However, the soft budget constraint environment does not result in a set of standard repayment periods of, for example, 30/60/90 days which can be consistently priced. To the extent that sales are made with the understanding that the repayment period will be indefinite, prior definition of terms of sale for collecting producer prices becomes very difficult. It is an important current objective of IMF technical assistance missions to study this problem in order to develop an effective but practical methodology for dealing with it.

Data collection for both the RPI and early, "hybrid" CPIs tended to ignore differences between the products available for pricing from month to month representing each of the detailed commodity items, thereby confounding quality and price change. During the period of falling average quality prior to economic liberalization, this practice resulted in an understatement of inflation. During the transition period, when average quality is expected to rise, inflation is likely to be overstated. In light of the importance of inflation measures to the Fund's programming and operational needs, this potential bias provided impetus for extending technical assistance on CPI methodology to the Baltic countries, the Russian Federation, the other countries of the former Soviet Union, and central Europe.

1/ For example, the Belarus WPI includes 353 items, while the Russian WPI includes 533. For comparison, the U.S. PPI includes approximately 500 items for mining and manufacturing industries, 500 for service industries, 3,200 commodity prices organized by type of product and end use, and 9,750 for specific products and product categories. See U. S. Department of Labor, BLS Handbook of Methods, Chapter 16. Producer Prices, Bulletin 2414, Washington, D.C.: U. S. Government Printing Office, 1992.

III. The IMF's Program of Technical Assistance on Consumer and Producer Prices to the Baltic Countries, the Russian Federation, and the Other Countries of the Former Soviet Union

1. Assistance on the CPI

From March 1991 to July 1995, the Fund's Statistics Department has provided technical assistance on consumer prices to 21 countries in transition from centrally planned to market economies. They include three countries each from central Europe and Asia, and 15 countries of the former Soviet Union, as detailed in Appendix I. CPI technical assistance activity has been substantial, as evidenced by the 59 missions undertaken over the period. The objective of Fund assistance is to implement in the shortest possible time monthly CPI compilation systems whose design gives due regard to internationally accepted statistical practice.

Among other things, the transitional period is characterized by the emergence of new private retail outlets ignored by the existing collection system, and rapid changes in the importance of various items in the budget and assortment of available item varieties. Fund technical assistance therefore focussed on establishing a methodology which would include newly emerging retail outlets in the pricing sample, introducing methods to insure comparisons between varieties of items that are strictly similar from month to month, and use of the modified Laspeyres formula. Along with the modified Laspeyres formula and increased emphasis on controlling the quality of the data, a less detailed item structure of approximately 300 or so more broadly defined item specifications has been recommended. This index configuration effectively raised the level of aggregation at which variety sampling is undertaken. Aggregation of price data follows a modified EUROSTAT classification tree, facilitating inter-country comparisons of the sources of price change, and, in principle, comparisons of price level.

2. Assistance on the PPI

Since 1993, the Fund has provided technical assistance to eight countries, as part of an ongoing program to develop internationally standard PPIs for a number of transition countries. Determining product prices when there are large, indefinite, and growing inter-enterprise arrears presents a particular challenge.

Assistance in the compilation of producer price indices began with the Russian Federation in late 1992, with Belarus, Estonia, Ukraine, and Uzbekistan in 1993, and with Bulgaria and Kazakhstan in 1995, as detailed in Appendix II. Conceptually, the WPIs produced in these transition countries are standard producer price indices, in that they cover gross sales from establishments at the factory gate. Coverage of the indices is also more or less standard, including primarily the civilian mining and manufacturing sectors, but generally excluding military manufacturing and services.

The problems faced in upgrading the PPIs of transition countries parallel to a large extent those faced in implementing CPIs. Chief among these are the problems of capturing and obtaining the cooperation of emerging privately-owned firms, and giving sufficient attention to pricing precisely defined product specifications from month to month. A further, special problem arises in producer price measurement that is closely related to the explosive growth in inter-enterprise arrears over recent years. It is believed that the sales price recorded in enterprise accounts and reported for inclusion in the WPI includes a finance charge for the expected duration the enterprise will hold a receivable in connection with the sale, and also includes a component for expected inflation over the period. Normal price measurement methodology attempts to control for the conditions of sale by including them in the detailed item specifications in the index. However, the soft budget constraint environment does not result in a set of standard repayment periods of, for example, 30/60/90 days which can be consistently priced. To the extent that sales are made with the understanding that the repayment period will be indefinite, prior definition of terms of sale for collecting producer prices becomes very difficult.

IV. Price Index Methodology

1. Formula

All price indices are nonparametric statistics calculated entirely with primary data, but they can be related to the microeconomic behavior of the consumers and firms comprising a market economy. Although writings on index numbers dates from at least the mid-eighteenth century, an extensive literature on these economic foundations has developed over the last twenty five years, with early papers dating from the 1920s. A significant contribution of the work in this area has been to show the power of nonparametric index numbers in capturing the behavior of households and firms, that until the mid 1970s most economists had thought would require parametric econometric and statistical modelling and estimation methods. These nonparametric indices are characterized by an array of basic formulae, some of which are very familiar to followers of economic indicators. In a few cases, the formulae have been adapted to feasible data collection systems for prices and weights and can be routinely compiled on a timely and reasonably frequent basis. The choice of formula therefore determines, and is determined by, the data collection system required to compile it.

a. The Laspeyres Index

The most common alternative approach for current price indicators is to use the Laspeyres formula, given by:

$$P_P^{0,t} = \frac{\sum_{i=1}^{n} p_i^t q_i^0}{\sum_{i=1}^{n} p_i^0 q_i^0} = \sum_{i=1}^{n} w_i^0 \frac{p_i^t}{p_i^0}$$

where w_i with superscript 0 represents the share weight of the *ith* item in the index in the base period. It can be seen from this formula that the Laspeyres does not require the frequent updating of the index weights, since they come from the base rather than current period. It is broadly the case, then, that the Laspeyres formula is used by the authorities in countries with market economies because weighting information can be collected less frequently, and need not be as current, reducing the response burden on the private enterprises from which most data are collected. Fund advice has followed this international practice.

The Laspeyres index can be used to construct a chain index by constructing period to period Laspeyres indices and multiplying them together to obtain the index for the desired epoch. A year's index would therefore be the product of month to month indices. This chain Laspeyres index over t+1 periods covering the epoch $[0,t]$ is calculated as:

$$P_{LC}^{0,t} = \prod_{\tau=1}^{t} P_L^{\tau-1,\tau}$$

b. The Paasche Index

The Paasche index prevalent in the U.S.S.R. and surviving for a period in the 15 countries succeeding it requires current weighting information. The formula is given by:

$$P_P^{0,t} = \frac{\sum_{i=1}^{n} p_i^t q_i^t}{\sum_{i=1}^{n} p_i^0 q_i^t}$$

where for the *ith* item in the *tth* time period (with $t = 0$ being the reference period), p is the item price and q is the item quantity. It can be seen from this formula that a monthly CPI would, for example, require household expenditure weights for the most recent month for which the indexis to be published.

The administrative data sources available under central planning made this index feasible, since reporting of current information could be successfully mandated by the government from state-controlled enterprises. In market economies, statistical agencies rely much more on voluntary cooperation from respondents, and therefore must be sensitive to the reporting burdens placed on them. Compiling and reporting sales and expenditure data used in the index weights is particularly onerous to respondents, both because of the time involved, and because the information requested is considered sensitive and confidential in a competitive business environment. The Paasche index has certain other drawbacks, as well. A

particular shortcoming is revealed in the context of the practice among a number of the transition countries to publish index percentage changes, but not levels. For example, probably the most defensible method of recovering a Laspeyres series from monthly and annual Laspeyres percent change data is to chain together month to month relatives implied by published percentage changes. The within-year transitivity of the Laspeyres formula permits use of same month of previous year percentage changes as a check on the monthly chain. On the other hand, because the Paasche lacks the transitivity of the fixed-base Laspeyres index, producing a consistent Paasche series from Paasche percentage change data is problematic.

As with the Laspeyres, the Paasche index can be used to construct a chain index by constructing period to period Paasche indices and multiplying them together to obtain the index for the desired epoch. A year's index would therefore be the product of month-to-month Paasche indices. This chain Paasche index over t+1 periods covering the epoch $[0,t]$ is calculated as:

$$P_{PC}^{0,t} = \prod_{\tau=1}^{t} P_P^{\tau-1,\tau}$$

c. The Fisher Ideal Formula

The Fisher Ideal index formula was introduced by Irving Fisher in The Making of Index Numbers, published in 1922. 1/ The index is computed simply as:

$$P_F^{0,t} = \sqrt{P_L^{0,t} \times P_P^{0,t}}$$

Assuming a fixed reference base as in the formula above, the requirements for compiling it are therefore identical with those for compiling a Paasche index. The Fisher may also be used to compute a chain index as:

$$P_{FC}^{0,t} = \prod_{\tau=1}^{t} P_F^{\tau-1,\tau}$$

where:

1/ The Making of Index Numbers, 3rd Edition, Boston: Houghton Mifflin, 1927; 1st Edition published in 1922.

$$P_F^{\tau-1,\tau} = \sqrt{P_L^{\tau-1,\tau} \times P_P^{\tau-1,\tau}}$$

A little algebra will show that the chain Fisher Ideal index can also be written as the geometric mean of a chain Laspeyres and a chain Paasche index.

Fisher argued for the formula because it satisfies a number of desirable mathematical tests for index numbers. The formula's superior approximation properties for the cost of living index have been established over many years. In a 1924 paper, the Russian economist/statistician Konüs showed that it is the exact cost of living index for consumers with the quadratic mean (order 1) utility function, of the form:

$$U(q) = \sqrt{q'Aq}$$

which, more to the point, is equivalent to a *cost of utility* function with quadratic mean (order 1) form: 1/

$$C(u,p) = \min_q [\, p'q : U(q) \geq u \,] = u \times \sqrt{p'Ap} \; .$$

The exact index number of consumer prices for a household with the above utility and cost functions for comparing the prices of periods (or locations) 0 and t would be written as:

$$I(p^0, p^t; A) = \frac{C(u,p^t)}{C(u,p^0)} = \frac{u \times \sqrt{p^t A p^t}}{u \times \sqrt{p^0 A p^0}} = \sqrt{\frac{p^t A p^t}{p^0 A p^0}}$$

The difficulty with this is that the index depends on the unknown parameter matrix A. However, Konüs showed that if consumers choose the quantities of goods they are observed to consume, q, to minimize the cost at price p of achieving the welfare corresponding to utility level u, then:

The exact index number for the comparison of periods 0 and t is therefore dependent entirely on observable prices and quantities, a powerful empirical

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1/ Konüs, I. B., "The Problem of the True Index of the Cost of Living," translation of 1924 original appearing in Econometrica 7, 1939, 10-29. The isomorphic character of the functional forms for the utility and cost functions is termed *self-duality* in the mathematics literature.

$$\sqrt{\frac{p^t A p^t}{p^0 A p^0}} = \sqrt{P^{0t}_L \times P^{0t}_P} = P^{0t}_F \ .$$

result.

Erwin Diewert showed in a 1976 article in the *Journal of Econometrics* that the Konüs result is even more powerful than originally thought, because the quadratic utility function is a second order differential approximation to any utility function. 1/ However, like the Paasche, the Fisher generally does not satisfy the *transitivity* or *base invariance* property considered desirable by users of indices, whereby the index from period 0 to period s multiplied by the index from s to t is equal to the index from period 0 to period t.

d. The Sauerbeck Index

This formula is a chain of fixed-weighted averages of period to period price relatives, where the links in the chain are given by:

$$P_S^{t-1,t} = \sum_{i=1}^{n} w_i \frac{p_i^t}{p_i^{t-1}}$$

The formula is found at various levels of aggregation in price indices around the world, but was particularly common in the statistical practice of the U.S.S.R. and the transition economy countries that succeeded it in 1991

1/ W. Erwin Diewert, "Exact and Superlative Index Numbers," Journal of Econometrics 4, 1976, 115-145. Inherent in the quadratic utility function is the property that changes in total expenditure do not affect the shares of items in the budget. However, in a recent University of British Columbia working paper, ("Axiomatic and Economic Approaches to Elementary Price Indexes," to appear in New Goods, T. Bresnahan and R.J. Gordon, eds. National Bureau of Economic Research, 1994) Diewert has shown that the Fisher formula is exact for comparing two time periods even when consumer preferences are given by *different* quadratic utility functions in the two periods, establishing that the Fisher formula can closely approximate changes in the cost of living even if the parameters of the utility function are themselves functions of total expenditure, and total expenditure thereby influences budget shares.

and 1992. It was originally introduced in equally-weighted form by Sauerbeck in 1896. 1/

e. Index number controversies, choice of formula, and economic concepts

(1) Substitution bias

Both the Laspeyres and Paasche indices use a single reference period to determine the basket of goods and the associated expenditure weights in making a given comparison across two time periods. The Laspeyres fixes this reference in a given time period for all possible comparisons of time periods, while the Paasche determines the reference period as the current period. The chain Laspeyres sets the reference period as the previous period for each index link, while the chain Paasche again sets the reference period of each index link as the current period.

For a given pairwise comparison of time periods during which the prices of various consumption goods have changed at different rates, a Laspeyres index based in the earlier of the two periods can be shown to be upward-biased in measuring the cost of living, while a Paasche index based in the later of the two periods can be shown to be downward-biased. Intuitively, the reason for this is that consumers can and do make substitutions between goods when their relative prices change. Therefore, the cost of maintaining the same level of welfare as the basket of goods bought in the reference period at the prices of the later period must be no larger than the cost of the reference basket of goods at the prices prevailing in the later period. This obtains since the latter estimate of the cost of maintaining the welfare of the earlier period presumes no substitutions would occur. The Laspeyres-perspective change in the cost of living (the compensating variation) resulting from the price change is the ratio of the cost of base period welfare in the current price regime with its cost in the base period. The Laspeyres index number is the ratio of the cost of the base period basket of goods purchased with the cost of the identical basket at current prices. Since its numerator is larger than the numerator of the Laspeyres-perspective cost of living index, it is an upward-biased measure of the cost of living.

There has been some controversy over the years as to the magnitude of Laspeyres bias. It is useful to point out that if (1) substitutions do

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1/ The earliest reference to Sauerbeck was thought to be Irving Fisher's reprint of correspondence with the journal The Statist in his book The Making of Index Numbers (p. 459, Appendix IV, 3rd Edition, 1927). As noted below in the section on Chain Indexes: Pro and Con, he wrote critically on the series of index numbers Sauerbeck initiated in a paper given at the Royal Statistical Society and subsequently continued by The Statist. Recently, an antecedent to Sauerbeck has been found by Diewert in an 1804 article by Carli. See W.E. Diewert, (1994), op. cit.

not occur, and/or (2) all prices change in the same proportion, the Laspeyres index measures the change in the cost of living exactly and thus has no bias. Since some substitution behavior is presumed to occur, the problem thus has to do with circumstances of nonproportional price change across different types of commodities. The degree of correlation in commodity prices therefore sets, to a large extent, the upper bound on Laspeyres bias. Empirical studies of the magnitude of Laspeyres bias have so far indicated that it is small, perhaps 0.2-0.5 percent per year. 1/ More recent work focussing on data with greater commodity detail may indicate biases of larger magnitude.

By a similar argument to that establishing the upward bias of the Laspeyres formula, the Paasche can be shown to be downward-biased. Considering the same two time periods, the Paasche-perspective change in the cost of living resulting from a price change is the ratio of the cost of welfare derived from the current consumption basket with the cost of achieving that welfare at the prices of the earlier period (the equivalent variation). The Paasche index number has the same numerator as this conceptual index, but its denominator is the cost of the current basket of goods consumed in the prices of the earlier period. Since this denominator is greater than the actual cost that would be incurred if substitution opportunities were exploited (the denominator of the Paasche perspective cost of living index), the Paasche consumer price index is downward-biased.

Other than the centrally planned economies that existed prior to the early 1990s, few countries have been able to produce a timely consumer price index using the Paasche formula, and the level of Paasche-bias in actual price data has received almost no attention in the professional literature. It would be reasonable to suppose its magnitude for a given comparison of two time periods to be similar to that of the Laspeyres formula, but opposite in sign.

It is straightforward, then, that because the Fisher index number is the geometric mean of Laspeyres and Paasche indices, it will tend to cancel the upward bias of the Laspeyres with the downward bias of the Paasche for a given pairwise comparison.

(2) Income/expansion effects

Transition economies undergo significant changes in real household income and in business sector output. Typically, large

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1/ For a discussion of the probable magnitudes, see Brent R. Moulton, "Basic Components of the CPI: Estimation of Price Changes, "in Monthly Labor Review, Washington: U.S. Bureau of Labor Statistics, December 1993, pp. 13-24. See also Marshall Reinsdorf and Brent R. Moulton, "The Construction of Basic Components of Cost of Living Indexes," to appear in New Goods, T. Bresnahan and R.J. Gordon, Eds., National Bureau of Economic Research, 1994.

contractions have been observed in both of these indicators in the early stages of liberalization. These changes induce a shift in the underlying preference and technology structure that consumer and producer price indices hold constant, both conceptually and in practice.

Large contractions in total expenditure by consumers are associated with significant shifts in expenditure shares toward necessities such as staple food and shelter and away from luxuries such as consumer durables and entertainment. These movements would be observed notwithstanding the parallel and also significant changes in relative prices. Under these circumstances, it is entirely possible for the Laspeyres consumer price index to lie below the Paasche, counter to the "normal" opposite relationship expected because of the direction of substitution bias.

Similarly, large contractions in output may be associated with significant shifts in output shares away from obsolete and/or low-quality manufactured products toward products (that may initially be few in number) of competitive quality and design. The contraction may also severely affect the share of manufactured items relative to resource (mining) products because of import competition in the first case and the need to export for foreign exchange in the second. It is possible under these circumstances for the Laspeyres producer price index to lie above the Paasche producer price index, again counter to the expected opposite relationship that would arise because of substitution bias.

Fund staff have characterized this as a problem of relevance of the index base, and recommended annual updating of the Laspeyres base for both CPIs and PPIs to deal with it. In the unlikely event that a Paasche formula could be implemented on a timely basis, another approach would be to calculate a chain Fisher Ideal index, a type of discrete Divisia approach to the shifting base problem. 1/

(3) "Disequilibrium" bias and changes in transaction services

The presence of queuing prior to freeing prices is indicative of disequilibrium, so that consumers are unable to achieve their optimal consumption bundles via purchases from state-owned outlets, and firms are

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1/ However, this approximation should be distinguished from the Törnqvist/Theil discrete Divisia formula used in productivity and monetary stock measurement, which use the Törnqvist index number formula. Under the postulated conditions, preferences or technology would clearly not exhibit constant item shares with changes in total consumption expenditure or output, and the "path independence" property of Divisia integrals would not hold (Charles R. Hulten, "Divisia Index Numbers," Econometrica 41(6), November 1973, 1017-1025). This explains why the conceptual Divisia index for this problem, as well as its chain Fisher approximation, lacks transitivity.

unable to maximize sales by producing an optimal mix of outputs from their given resources. The price index compiler's view of this is that there has been an improvement in transactions technology pre- and post-liberalization, which would tend to go undetected by standard index methodology. Similarly, the "hardening" of budget constraints squeezing interenterprise arrears out of the economy would correspond to a reduction in the transaction services provided by sellers, because the duration and level of receivables permitted in the delivery of product would shrink. This usually undetected decline in transaction services would result in understatement of inflation by the Laspeyres PPI. 1/

By implication, any omitted variable in a price index, such as search and queue waiting time and provision of financing to buyers, that (1) is costly in the sense that its elimination would result in lower optimal consumer expenditure, or higher optimal sales by firms, other things equal, and (2) changes over the period of observation, will introduce bias in the standard Laspeyres and Paasche indices. For example, in advanced market economies, the introduction of point of sale scanning equipment has reduced the transactions costs for making retail purchases in very much the same way that freeing of prices has eliminated queues and reduced waiting in transition economies. This is probably an unrecorded effect in most CPIs worldwide since there are unlikely to be product variety specifications including the type of point of sale technology by which a good is purchased, in addition to its more intrinsic characteristics.

This is a difficult and rather exotic class of measurement problems associated particularly, but not exclusively, with transition economies. It can be ameliorated by adding retail/transaction services to the detailed (variety) specifications in the index. There are limits to the detail that can be added to these specifications, however, since the practice of linking to accommodate changes in the assortment of goods is common enough in transition economies without considering transaction characteristics. The viability of index calculations depends on the overlap of at least a few observations with the same specifications in the prices collected from month

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1/ Of course, the early transition phase seems to be characterized by an explosion in industrial transaction services provided by sellers. The latter occurs because of indirect government intervention in the industrial sector to avoid bankruptcies and unemployment. The mechanism used is effective extension of trade credit by the Government funding losses in the state enterprise sector. (See Hugh Bradenkamp, "Conducting Monetary and Credit Policy in Countries of the Former Soviet Union: Some Issues and Options," IMF Working Paper WP/93/23, March 1993; George Kopits, "Lessons in Fiscal Consolidation for the Successor States of the Soviet Union," IMF Working Paper WP/93/54, June 1993; John Odling-Smee and Henri Lorie, "The Economic Reform Process in Russia," IMF Working Paper WP/93/55, July 1993.) In the early transition, then, the PPI calculated without tracking the increasing volume and lengthening duration of receivables would overstate inflation.

to month. One approach actually followed in some transition economies for the CPI is to stratify the sample of retail establishments by type (particularly by state, established private, and informal private ownership), and Fund staff have advised adding expected repayment period as a transaction characteristic to the detailed specifications in the PPI.

(4) Choice of base

When constructing a Laspeyres index, the question arises what period to use as a base and how often should it be updated? The choice of base is particularly critical under the high and unevenly distributed inflation conditions that characterize the early phases of transition from centrally planned to market economy. Fund advice follows the international practice of establishing a full year period for the base to average out seasonal fluctuations in expenditure shares. By implication, the long-term price relatives in the index should therefore also be calculated with base given by a weighted average of the price of each variety over the months of the base year. The frequency of updating depends on the pace of structural change occurring in the economy. Fund advice has uniformly recommended updating with an annual frequency in the Baltic countries, the Russian Federation, and the other FSU countries, where annual household expenditure data for reweighting the CPI are available with about a two-month lag, and the annual value of production data for reweighting the PPI are available with an approximately two year lag.

To implement the annual average base concept, it is necessary to consider how the monthly (or even weekly) weights of this average would be determined, conceptually and in practice. Let time t be given by the ordered pair (m, y), where $m = 1, 2, \ldots, 12$ denotes month and y denotes year. According to basic accounting practice, the principle that should be observed in time aggregation is to preserve the aggregation of quantities over time by simple summation. 1/ The quantity of a year's purchases or sales should equal the sum of the monthly quantities purchased or sold; that is:

$$q_{ij}^{y} = \sum_{m=1}^{12} q_{ij}^{my} .$$

1/ We could entertain an alternative principle, based on the concept of *dated goods*. Under this concept, a January good (variety i of item j) is not the same as a June good, and hence would not necessarily receive the same weight in aggregating monthly quantities consumed or produced to arrive at a yearly figure. See W. E. Diewert, "On the Problem of Seasonal Goods," in Price Level Measurement: Proceedings of a Conference Sponsored by Statistics Canada, 1983.

The corresponding average price over year y of variety i of item j would then be:

$$p_{ij}^{y} = \frac{\sum_{m=1}^{12} p_{ij}^{my} q_{ij}^{my}}{\sum_{m=1}^{12} q_{ij}^{my}} = \sum_{m=1}^{12} p_{ij}^{my} \frac{q_{ij}^{my}}{\sum_{m=1}^{12} q_{ij}^{my}}$$

which is the quantity-weighted average of the prices over the months m of the year. The same principle would apply if data of weekly frequency were aggregated into an annual average.

(5) Chain indices pro and con

Diewert has consistently argued that, because adjusting the base over small changes in prices and quantities improves the local approximation properties of index numbers, chaining should be adopted as the preferred methodology in price index compilation. 1/ Fund advice has been consistent with this in advocating annual adjustment of the base for both CPIs and PPIs in transition countries. Although changes between years may not be "small," they are smaller than if base adjustments were made more infrequently.

However, updates with too high a frequency may introduce new problems. Szulc has argued that updating the base of a Laspeyres or Paasche index when there are large negative correlations in the series of short-term price relatives can cause substantial "drift" relative to the fixed-base Laspeyres or Paasche. 2/ In transition economies, the behavior of prices can, indeed, induce substantial drift in chain indices, as the authorities tend to begin the price liberalization process in stages staggered over commodities and sectors, causing large, discontinuous changes in prices followed by intervals of little if any change. Such a pattern introduces significant negative serial correlation in the short-term price relatives. The problem of drift becomes particularly acute when the Sauerbeck chain formula is used to aggregate detailed Paasche series, as has been the case

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1/ See "Exact and Superlative Index Numbers, Journal of Econometrics, 1976, and "Superlative Index Numbers and Consistency in Aggregation," Econometrica, 1978.

2/ See "Linking Price Index Numbers," in W. E. Diewert and C. Montmarquette, eds, Price Level Measurement: Proceedings of a Conference Sponsored by Statistics Canada, 1983, 537-562. Actually, the condition he cites for the Laspeyres and Paasche chain indexes is positive correlation between the long-term quantity relatives and short-term price relatives when the index is expressed in its "short-term relative" update form. See the section on Estimation Issues below for this "Modified Laspeyres" version of the Laspeyres formula, and Annex 6 on Szulc's analytical framework.

in a number of transition countries. 1/ Lequiller and Zieschang report large biases arising from this source in recent data from several transition countries. 2/ A detailed version of their analysis is given in Appendix IV.

2. Data collection

a. CPI

(1) Scope and definition of the universe

The consumer price index should cover the prices of all consumption goods and services purchased by resident households in an economy. By definition, consumption goods would exclude goods and services purchased for investment purposes, or that part of purchases of goods and services for which there is an investment motive. The most important service in the household budget for which this distinction is important is housing, as the purchase of a dwelling permits the enjoyment of a flow of housing services whose price is the rental value of those services, but also provides a store of value and a source of wealth. Only the former services are in-scope for the CPI. Finally, most countries include only the urban population in the universe for the CPI, but the rule is not universal.3/

(2) Units of analysis and classification

As with any price index, the unit of analysis for the CPI is the *transaction*, which is characterized by the purchase of a quantity of a specific consumption commodity (termed a *detailed specification*) at a price stated either in domestic monetary units or in units convertable to domestic money. These transactions are undertaken by *households*, one of the four types of *institutional units* in an economy that are identified in the 1993

1/ Fisher, in his book The Making of Index Numbers, notes the Sauerbeck's systematic bias on p. 86, foreshadowing the work of Bohdan Szulc that was published 81 years later. Fisher's views on this formula are summarized by the following: "And if this book has no other effect than to lead to the total abandonment of the simple arithmetic type of index number, it will have served a useful purpose." (The Making of Index Numbers, 3rd Edition, 1927, p. 30).

2/ "The Problem of Drift in the Producer Price Indices for Countries of the Former Soviet Union," IMF Staff Papers, 41(3), September 1994, 526-532.

3/ Generally, urban coverage is satisfactory because most economic activity occurs in urban areas. Resource constraints also play a role, since high population density makes sampling less expensive and more timely, requiring less travel to obtain information for the index. Finally, management of collection is easier when the collection staff are themselves geographically concentrated, assisting in maintaining quality control.

System of National Accounts. 1/ The approach to selecting transactions for sampling household transactions is specific to the CPI and will be discussed further below. CPI transactions are generally organized according to the types of goods purchased and the types of households purchasing them, as well as, possibly, their geographical location. As regards the commodity classification defining the types of goods, it is recommended that international standards be followed by implementing a variant of the end-use classification for expenditures of household institutional units stated in the *1993 SNA*. 2/ The EUROSTAT classification is one such system, and has been adapted for use in specific countries by IMF technical assistance missions on the CPI, (Appendix V).

(3) Sample design and coverage

In developing a plan for obtaining repeated monthly observations of the prices paid in consummated transactions, the sample design for the CPI, consideration is given to the types of institutional units engaged in these transactions. On the purchasing or demand side are households, while the selling or supply side is comprised primarily of private corporations, but may also include government or non-profit institutions depending on the country and commodity. Generally, record keeping is better on the supply side of these transactions, and a design is formed to select a sample of private for-profit, non-profit, and government establishments in order to interview their representatives on the establishments' transactions with households for the sale of consumption commodities.

Samples generally follow a stratified design with the following five levels from broad to specific: major commodity groups, (commodity) item groups, geographical regions, retail outlets, and (commodity) varieties or detailed specifications. The coverage of the first level is comprehensive, including the value of all in-scope consumption commodity transactions for broad commodity groupings. A set of item groups, or simply, items, is then selected to represent each of the broad groups. These are samples, whose coverage is necessarily incomplete. This set of items must then be represented for the full geographical scope of the index.

Generally, the geographical universe, say, the entire urban population, is represented by all major urban centers and a sample of minor urban centers dispersed throughout the country. These selected areas are often called *Primary Sampling Units* or *PSUs*. The crossing of the item

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1/ System of National Accounts 1993, Inter-Secretariat Working Group on National Accounts, Brussels/Luxembourg-New York-Paris-Washington, D.C.: Commission of the European Communities/Eurostat-International Monetary Fund-Organization for Economic Cooperation and Development-United Nations, 1993. The four types of institutional units are Households, Corporations, Non-Profit Institutions, and Government.

2/ Classification Of Individual Consumption by Purpose (COICOP), System of National Accounts 1993, Chapter XVIII. Functional Classifications.

sample with the PSU sample generates a set of cells to be represented in turn by a set of retail establishments or *outlets*. The fifth and final level serves to identify classes of transactions whose terms will be transcribed from the records of sampled retail outlets every month to obtain the prices for the CPI.

(4) Index weights

The index weights in CPIs come from household expenditure surveys. In addition to their role in index aggregation, they are useful in implementing the design of the price sample. Generally, the most recent survey information for which there are tabulations should be used in compiling the weights of the broad commodity aggregates. The degree of detail in household expenditure survey coverage of commodities in most transition countries has been insufficient for construction of the item weights, and the survey data has been supplemented, where necessary, with information from the retail sales reporting systems already used in currently compiled retail price indices.

The household expenditure surveys in most transition countries are based on a sample of employees of state sector enterprises and their pensioners, which have become progressively unrepresentative as new firms are created and employment in the state sector is displaced by employment in the poorly covered private sector. In addition, an increase in unemployment is not uncommon during the transition phase, creating a larger population of households whose expenditures cannot be adequately covered in an enterprise-based design. Most market economies have implemented geographical or area designs for household expenditure surveys that do not have inherent coverage biases of this sort. A number of transition countries are receiving assistance on household survey redesign and implementation from other international agencies besides the Fund, and from bilateral donors. In the interest of serving the near-term needs of policy users Fund CPI work has proceeded on the basis of existing household expenditure information.

(5) Item selection

In principle, all samples at all levels of stratification should be selected with probability proportional to household expenditure. Hence, in selecting items within major group, their expenditure levels should be sorted by size, a sampling interval selected for expenditure, and with a random start, items should be included into the sample if integral multiples of the sampling interval for expenditure plus the start value falls within the quantiles of the expenditure distribution corresponding to those items. The item weights would be the total expenditure of the major group divided by the item expenditure.

In practice, this procedure is not routinely followed because of a lack of computer facilities and time for making the selection. Judgemental selections are made instead that heuristically follow the probability proportional to size (pps) principle.

The total number of items depends on the size and complexity of the economy. Industrial countries' CPIs contain approximately 350 items. Fund missions have recommended no more than approximately 300 items to countries receiving technical assistance. This number is based, in the final analysis, on judgement formed by experience that the smallest number of reasonably homogeneous commodity groupings is about 300 in most transition economies. 1/ Most advanced market economies employ fewer than 400 item groups to measure price change in a much larger assortment of commodity varieties.

(6) Outlet selection

In principle, outlets should be selected within area (PSU)-item cells with probability proportional to the outlets' sales (PPS) of the item. The problem with this methodology in practice is that it requires an enumeration of outlets within area and their item sales from which a PPS selection can be made. Such lists are unavailable in transitional economies where the emergence of private retailing may take the form of street vending and weekend markets, rather than sales from shops with fixed addresses. In lieu of PPS sampling, then, an informal area design can be used which relies on field staff to select outlets that are volume sellers within their PSU of each item for which prices are to be sampled. This informal design has been implemented in the transitional economies that have received Fund technical assistance.

(7) Variety selection

Ideally, varieties should be selelcted within each sampled retail establishment with probability proportional to sales of the variety. Sampling methods have been developed for this and are in use in a number of market economies. The methodology is ususally called *disaggregation*, and entails undertaking a product study in the central office that identifies the price-determining characteristics of the product. The product study is then used to develop sampling documents instructing the price collector to effectively stratify the varieties of the product for sale in a sampled outlet on the basis of the price-determing characteristics, selecting a detailed specification through a sequence of questions put to the establishment representative.

The staff, information, and printing infrastructure requirements of disaggregation were judged by Fund experts to be too stringent for countries newly initiating consumer price index compilation systems. In the interest of producing useful data for policymakers in the short term, an informal methodology has been recommended instead. Selection of detailed specifications is assigned to the data collectors with instructions to select varieties from each sampled retail outlet of items that are volume

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1/ We refer here to reasonably homogeneous price movements, in addition to similarity among the goods in the same group.

sellers and in relatively stable supply. Descriptions of the selected varieties or detailed specifications are then recorded for reliably pricing the identical specification in succeeding months.

(8) Price collection

CPI price collection is undertaken by personal visit every month with instructions to collectors that the selected varieties, as described in detail at the time of selection, be consistently priced. Fund advice has been to collect six to eight varieties per item in each collection area, typically a city or district thereof. If there is an interruption in availability, a new variety may be selected, but its price may not be directly compared with the variety it replaces unless it is deemed to be essentially identical. Normal recommended practice for new and replacement varieties is to link them into the short-term relative estimate for the item in the data collector's area, discussed further in the Estimation Issues section.

To reinforce good collection practice and distribute the calculation burden of the index, Fund experts have designed a collection form on which prices are recorded for a given item group in a given sampling area along with the characteristics of the varieties priced, and on which the short-term relative calculations can be documented. The form is shown in Appendix III. Data on the form cover the current and previous months. Preparation of the form for each monthly collection requires that the collector fill in the information collected for the previous month in the space for "previous month" information on the current month's form. For example, to prepare for February collection, product description information and collected prices would be transcribed from the "current month" area of the January form to the "previous month" area of the February form.

b. PPI

(1) Scope and definition of the universe

The target population of the producer price index is comprised of all resident establishments engaged in a range of activities considered feasible for price measurement. Until recent years, this has included mining and manufacturing, may include agriculture, weapons production, and transportation, telecommunications, and energy distribution, but typically has excluded any other service activities. Efforts are now under way in a number of countries to extend coverage of the PPI to business, retail and wholesale, and personal services, but progress has been slow.

(2) Units of analysis and classification

The unit of analysis of the PPI is the sales transaction between a business establishment and another buyer, either business or nonbusiness. PPI transactions therefore cover intermediate consumption as well as sales to final consumers. PPI transactions are generally classified by both

industry and product. Fund experts have recommended the International Standard Industrial Classification (ISIC), Revision 3 for classifying establishments. For the time being, product classification has been left to the indigenous system of the country. A number of formerly centrally planned economies use the Classification of Branches of National Economy (CBNE) system of industry classification, a five digit system, and a ten digit product classification system carried over from the central planning era. The authorities have either directly converted to the ISIC, or have undertaken a revision of the CBNE to allow mapping into the ISIC system.

(3) Sample design and coverage

Most formerly centrally planned economies are continuing annual establishment surveys and periodic updates of buiness registers from the pre-transition period. The sample designs are generally technically adequate, but suffer from primary data weaknesses beginning with incomplete coverage of newly formed, private establishments in the business register. This lack of coverage of important new activity is then propagated to the samples of establishments drawn from the register for each (generally five digit CBNE) industrial sector.

(4) Index weights

Most transition countries operate annual enterprise surveys collecting production, value of output, and cost information. The results of these surveys, as in the rest of the world, underly the weights of the PPI, which are usually compiled on a gross value of output basis. The chief difficulties with the existing industrial and agricultural production surveys are bound up with the adequacy of the business register, which is the basis for the selection and weighting of the establishment samples from which survey information is collected. As noted above, during transition the coverage of the business register degrades because of inadequate information on new business formation in the private sector. This degradation carries through to the industry and product weights used in the PPI, as well as the transaction sample used for price collection discussed below. Fund missions on price statistics and quarterly national accounts compilation have advised national statistical offices on the importance of the business register in obtaining representative samples and accurate price statistics, as have technical assistance missions from EUROSTAT and other agencies dealing principally with national accounts.

(5) Establishment selection

Establishments are, as a rule, selected according to their importance measured by the value of production listed on the business register. The procedure at least heuristically mimics sampling with probability proportional to size. Most formerly centrally planned economies are organized into a number of administrative regions, many of which possess considerable autonomy. Although the industry sample is selected by the central statistical office, augmentations and modifications are made in the

regional centers according to local conditions. Fund experts have advised annual augmentations of the national sample as new enterprises are discovered, either by field staff undertaking current collections, or in reviewing updates to the business register.

(6) Item selection

Generally, the commodity groups or items in the PPI to be priced within each industry are also determined by the central statistical office, by selecting a representative set of ten-digit product groups on the basis of value of production data from annual industry surveys. Once establishments are selected into the PPI sample, the national list of representative items are given to enterprise managers from which a set that is representative and priceable in that enterprise is determined jointly by management and local statistical office staff, possibly including product groups not in the national PPI list as determined by the central office. Again, the selection of items is at least heuristically, if not actually, PPS.

(7) Variety selection

Varieties are selected by enterprise management for the assigned ten-digit product items in the course of filling out a small data collection form monthly. Fund experts have urged data collection staff to engage in more personal contact with the reporting individuals in the sampled establishments, both for product selection and monitoring of price reports and specification changes. Further, because of the substantial changes occurring at the establishment level, more frequent reselections of product varieties for pricing in the index has been recommended, with the general rule that one fifth of establishments should be revisited each year. Changes at the establishment level may be sufficiently significant that reclassification of the establishment into another industry is required.

(8) Price collection

Price collection is undertaken with a mail survey. The form, as noted earlier, is compact, asking for a brief variety description, the price of the current month, the price of the previous month, and the price of twelve months earlier. The number of varieties requested depends on the size of the firm and assortment of its output, but ranges from one to five or six per product item.

3. Estimation issues

Practitioners, particularly in the United States, sometimes refer to the formula actually used to compute a Laspeyres index as the "modified Laspeyres." The modified Laspeyres is merely an algebraic transformation of the standard formula, written as a linear function of short-term price relatives, which are formed for each item as the ratio of the current period price with that of the previous period. The coefficients of the short-term

relatives are the so-called "cost weights," calculated for each item in the index as the product of the base period weight with the long-term price relative of the previous reporting period, which is formed as the ratio of the last-period price with its base period value. The modified Laspeyres formula is written:

$$P_L^t = \sum_{i=1}^{n} c^{0t}_i r^t_i$$

where the "cost weight" c and the short term price relative r are given by:

$$c^{0t}_i \equiv \frac{p^{t-1}_i}{p^0_i} w^0_i$$

$$r^t_i = \frac{p^t_i}{p^{t-1}_i} \ .$$

The "modification" in this approach lies not in the formula itself, which is equivalent to the standard formula, but in the fact that the short-term relatives must, in practice, be estimated from samples of prices, which may, from time to time, include new varieties of goods, or exclude varieties that are no longer available. 1/ The long-term price relatives are then built up as a chain of the estimated short-term relatives. The modified Laspeyres form thus expresses the index in "update form" as a function of variables, the short-term relatives, which must first be estimated before calculation can proceed.

A second modification to the standard formula arises when the pricing surveys from which the price relatives are computed begin in a later period than that of the expenditure or sales weights. If item price indices for the interval between the period of the weights and the beginning of the price survey (and thus the long-term relatives) are available (as would be the case when the design of the pricing survey is revised and updated),

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1/ The context of price index compilation worldwide and implicit in this paper is that the number of product types transacted in an economy is too large to price all at a reasonable cost, and sampling must be used to produce accurate estimates for the index with a manageable data collection effort. When samples are used r becomes an estimate for an item class composed of product varieties in that class, and no longer has the simple form shown above.

standard practice is to "move" the reference period of the weights forward to the beginning of the price survey by multiplying the item weights by these available indices. The base of the index is generally taken as the period beginning the price survey, and these "moved" weights are then taken as estimates for the true values in the effective base period. When no price information is available for the intervening period between the weight reference period and that of the price relatives (as when the index is being started from scratch), the shares implied by the available weights are typically used without adjustment as estimators for those of the base period.

Fund missions have recommended use of the modified Laspeyres calculation approach in transition countries, because their item price samples change composition frequently, requiring estimation of the short-term relatives, and there are occasionally mismatches between the reference period of the weights and the beginning period of the price survey.

a. Short-term price relatives

The short-term relative must generally be estimated from samples of *varieties* of the item being priced.

To represent varieties we will add another subscript to the price p, as

$$p_{ij}^{t}$$

where t indicates the year, i the item, and j the variety of the item. As an example, for the fruit and vegetables item *apples*, there might be the varieties *Gala*, *Jonagold*, *Red Delicious*, *MacIntosh*, and so on, available for sale, depending on the season.

The question arises what estimator to use to calculate the item short-term relative price change from the variety information? Turvey, *et al*, recommend two approaches. The first is the ratio of average prices of *matched varieties* of the item, as

$$r_i^t = \frac{\frac{1}{n_i^t}\sum_{j=1}^{n_i^t} p_{ij}^{t}}{\frac{1}{n_i^t}\sum_{j=1}^{n_i^t} p_{ij}^{t-1}}$$

where only varieties j for which prices are observed in *both* t and t-1 are included in the averages in the numerator and denominator. The second estimator is the geometric mean of matched varieties, as

$$r_i^t = \left[\prod_{i=1}^{n_i^t} \frac{p_i^t}{p_i^{t-1}} \right]^{\frac{1}{n_i^t}}$$

Although expressed in unweighted form, as appropriate for so-called "self-weighted" samples, both estimators for the short-term relative can also be expressed in weighted form if data are available, and/or the variety samples are themselves stratified.

Both of these estimators possess the desirable property that, if the same set of varieties is available from period to period and prices follow a course which returns to their values in some earlier period, the product of the short-term relative estimates for the interval from the earlier period to the present is one. This simple property, the *transitivity* property, is especially important in the case of seasonal items, whose prices may actually follow such a cyclical course.

Transitivity is not possessed by another estimator for the item relative actually rather widely used across the world, including the Baltic countries, the Russian Federation, and the other FSU countries. This *Sauerbeck* estimator is given by

$$r_i^t = \frac{1}{n_i^t} \sum_{j=1}^{n_i^t} \frac{p_{ij}^t}{p_{ij}^{t-1}}$$

which can substantially overestimate price change when the variety short-term relatives are negatively serially correlated, as discussed at some length in Appendix IV. As with the other two relative estimators, the Sauerbeck formula can be and is, in many instances, calculated using weights for the varieties.

b. Imputation of missing prices

All price index compilation systems encounter missing data. Missing prices can arise because certain goods are temporarily unavailable because of supply interruptions or seasonal production or use cycles, permanently unavailable because of obsolescence or change in regular sources of supply, or because the sampled outlet closes or relocates. Another source of missing prices is associated with the introduction of new goods into the index between index revision periods. Often the price of the good in the previous month, and in the base period is not known and must be estimated as a missing price.

(1) Varieties. When the price of a variety sampled within an item group is unavailable, the short-term relative calculation methodology discussed above automatically imputes the short-term relative change of available varieties within the item to that variety, and its price is "moved forward" by that relative change. It is an important part of Fund-recommended methodology that the prices of temporarily unavailable varieties, for example, in seasonal produce items, be imputed forward to provide a correct estimate of price level when the variety again becomes available. When such a good reappears after a supply interruption, imputation of its price as if it were a new good, by linking it in in the second month of its reappearance, does not give a correct estimate of the index level, because the chain of short-term relatives between the month of disappearance and reappearance then in general does not equal the direct item relative between those two months.

On the basis of the recommended ratio-of-averages estimate for the short-term relative, this would proceed in the following sequence:

Period t-1: All selected specifications for the item are available	$r_i^{t-1} = \dfrac{\frac{1}{n_i^{t-1}} \sum_{j=1}^{n_i^{t-1}} p_{ij}^{t-1}}{\frac{1}{n_i^{t-1}} \sum_{j=1}^{n_i^{t-1}} p_{ij}^{t-2}}$
Period t: Variety k becomes unavailable	$r_i^t = \dfrac{\frac{1}{n_i^t} \sum_{\substack{j=1 \\ j \neq k}}^{n_i^t} p_{ij}^t}{\frac{1}{n_i^t} \sum_{\substack{j=1 \\ j \neq k}}^{n_i^t} p_{ij}^{t-1}}$ $p_{ik}^t = r_{ik}^t p_{ik}^{t-1}$
Period t+1: Variety k reappears in the sampled outlet/establishment	$r_i^{t+1} = \dfrac{\frac{1}{n_i^{t+1}} \sum_{j=1}^{n_i^{t+1}} p_{ij}^{t+1}}{\frac{1}{n_i^{t+1}} \sum_{j=1}^{n_i^{t+1}} p_{ij}^t}$

(2) Items and higher-level groups

When all of the varieties are unavailable for an item group, it is necessary to estimate the change in those prices for the item short-term relative. Standard international practice is to estimate the short-term change of an item index as the short-term change in the next higher-level group to which the item belongs. This short-term group relative is usually calculated as the ratio of the group index for the current month with the group index for the previous month, including only the items within the group having prices in both the current and the previous months. It can be equivalently derived as the cost-weighted average of the short term relatives for items having prices in both the current and previous months.

4. Calculation and data processing

a. Manual versus computerized computation

The availability of computer equipment and software is rapidly improving in most formerly centrally planned economies. Early Fund technical assistance teams encountered limited numbers of personal computers with limited capacity in processor performance, memory, disk drive storage, and speed. The model Fund compilation process therefore makes use of relatively plentiful field staff to compute the short-term price relative for each item on the item price collection form. The effect of this arrangement was to reduce the number of records to be processed by the central office by a factor of about six (the recommended number of price quotations per item) times the number of areas in which the item is priced, by comparison with central processing of the elementary price data. The software performing the calcualtions in the regional or national center, including the item index imputations as necessary, is based on Lotus or SuperCalc spreadsheets. Larger countries, such as the Russian Federation and Kazakhstan, have programmed parallel calculations using database software.

More recently the IMF Statistics Department, with the assistance of its Bureau of Computing Services, has undertaken the design and implemetation of a prototype price index calculator incorporating data entry and editing features, simplified new variety intorduction, and automated imputation of missing prices and item indices. Like the large transition countries, the software platform is a database rather than spreadsheet program. The reason a database approach was selected was primarily to facilitate management of the entire micro-database of collected prices on electronic media, rather than on paper forms. In most countries the number of prices reaches tens of thousands every month. The CPI in the Russian Federation is produced from over 900,000 price quotations per month with up to 50,000 records processed in each of 79 regional administrative centers. A second advantage of the database software platform is that it can be flexibly programmed to internalize the variety price imputation operation, minimizing computation errors, particularly in tracking the prices of seasonal varieties and items.

Both of these model software systems have been used to demonstrate the methodology and check calculations should the authorities prefer to develop their own approaches to calculation. As such, they represent technical assistance tools for Fund staff, but do not represent a Fund-supported software standard in the sense, for example, of the United Nations Trade and Development Conference's ASYCUDA system for processing customs data.

b. Division of tasks between national and regional offices

The degree of decentralization in the data processing task depends on a number of factors. Fund technical assistance work in the Baltic countries, the Russian Federation, and other countries of the former Soviet Union began in the early 1990s with the introduction of CPI methodology respecting international standards. The CPI received priority because it is the headline price indicator, covers the largest sector of expenditures in the economy and is used in part to assess the effectiveness of fiscal and monetary policy determined by the national authorities and monitored by the staff of the Fund.

In the early 1990s, the statistical offices of the formerly centrally planned countries had very large staffs dispersed into a large number of administrative regions. There was very limited computer capacity, particularly in the regional centers, but also in the central office. Early implementations of price collection systems for the CPI therefore made maximum use of plentiful labor. The Fund recommended a model price collection workflow that designated to field staff the tasks of (i) choosing retail outlets for the assigned item groups, (ii) choosing varieties to price within outlet, (iii) documenting the selected varieties, (iv) recording the prices of selected varieties monthly, and (v) calculating the monthly short-term price relative. A model price collection form (Appendix III) was designed to reinforce good practices in tasks (iii)-(v), particularly in comparing like collections of varieties from month to month, a weakness of the price compilation systems the methodology was designed to replace.

c. Updates and revisions

Fund advice has been uniformly to update the base of both the CPI and PPI annually because of the rapid structural changes occurring in the transition economies. The advice was implemented in CPI systems by updating the index weights using household expenditure survey data from the previous year, in view of the very timely processing of these surveys in most transition countries. Industrial surveys are typically also run annually, but processing takes time, and the PPI weights are typically updated from survey data collected two years prior to the current year. The updates are incorporated by linking all items series, generally in January of each year.

The CPI and PPI series follow different policies on revisions of data. Because CPIs are used in contract negotiations, revisions are problematical, and are not undertaken unless large changes in the published data result. PPI data are traditionally revised, in part because the reporters themselves may have only preliminary information at the cutoff date for monthly index compilation. Revision policy for the PPI varies. In the United States, up to four months of data are revised. The PPI systems currently operating in the formerly centrally planned countries allow, in principle, revisions of up to twelve months of data, since each monthly report form asks for the price of the corresponding month of the previous year. Fund models for PPI compilation make provision for revision of five months of data preceeding the month of the report.

d. Publication and dissemination

Price index data were not widely disseminated in centrally planned economies. The "need to know" criterion for receiving official publications on price developments has been slow in yielding to a more modern, transparent policy of wide dissemination of the results, including the underlying commodity and/or industry detail, and the methodology of official price measures. Fund advice has encouraged publication of index levels relative to the current reference base of the index, in addition to the percentage changes normally released in published reports. These recommendations have slowly gained acceptance in transition countries, and current releases of some of the earliest recipients of Fund technical assistance now contain index levels in reasonably disaggregate detail, as well as brief descriptions of the sources of change in the aggregate index. Dissemination is improving as well, particularly for CPI data, as both official compilers and users of the data have become more familiar with the results, methodology, and presentation.

V. Price Indices in the Compilation of Constant Price GDP

The use of price indices for compilation of national accounts in constant prices has been a mainstay of national accounting for many years. Guidance on the uses of price indices in the national accounts was published in a manual by the United Nations in the late 1970s. 1/ This reference has now been updated by Chapter XVI of the *1993 SNA*. The purpose of this section is to comment generally on the application of accepted guidelines for the use of price indices in the national accounts within the context of the transition economies of the Baltic countries, the Russian Federation and the other countries of the Former Soviet Union. The section closes with brief remarks on classification.

1/ United Nations Statistical Office, Guidelines on Principles of a System of Price and Quantity Statistics, Statistical Papers series M, No. 59, 1977.

1. Units of analysis and classification

Fund assistance has encouraged the use of a EUROSTAT-based commodity classification for detailed consumer price indices, and the ISIC for producer prices. The transition to a new, more internationally compatible commodity classification for consumer expenditures and prices based on the EUROSTAT structure has been undertaken without major difficulty in the countries with which the Fund has worked on CPI development. On the other hand, because existing collection and compilation systems use the CBNE, it is expected that the CBNE and ISIC industrial classifications may coexist for some time. It is of particular help in encouraging international standards to have ready-to-run computer applications for database management and index compilation that incorporate these classification systems. Fund missions have undertaken implementation of such index database and calculation software in a limited way, modelling prototype systems using spreadsheets, and most recently, database software compatible with FoxBase, which is widely available in the Baltic countries, the Russian Federation, and the other countries of the Former Soviet Union.

2. Value added by industry

Chapter XVI of the *1993 SNA* discusses an integrated set of price and volume measurements consistent with the system of national accounts. Practically speaking, separation of price and volume effects is achieved with a variety of methods that can be classified into two groups: those involving direct measurement of prices for deflation purposes, and those involving direct measurement of quantities or physical indicators for extrapolation of the aggregates of a reference period. This paper is concerned with the first, deflation group of methods.

Under the constant price concept the Paasche is the preferred price index formula, because its use in deflation is consistent with a Laspeyres quantity index. The Laspeyres quantity index is preferred in national accounts volume measurement because, as shown by Fisher and Shell, 1/ it underestimates volume change when producers are able to change product mix in response to changes in relative prices, while the Paasche quantity index overestimates volume change. This conservative feature of the Laspeyres quantity index is considered desirable, given the importance attached to volume change in the measurement of national economic performance and welfare.

1/ Franklin Fisher and Karl Shell, The Economic Theory of Price Indices, New York: Academic Press, 1972. This discussion is in the context of deflating the gross sales value of output. The effects of over- and under-estimation of the implied volume measures by deflation of the value of output and intermediate purchases by Paasche output and input price indices are indeterminate in the double deflation of value added, discussed below.

a. Method of deflation

Industrial price indices can be used for deflation of value added under "double deflation" or "single indicator" methods, depending on the scope of the PPI compilation system.

(1) Double deflation

It has been useful to think of constant price value-added in terms of the difference between the value of production and the value of purchases from other establishments (intermediate consumption) in the prices of a reference period. The constant price output and cost figures for computing constant price value added can be obtained in principle through deflation of current price sales and costs by appropriately constructed Paasche price indices for sales and inputs, leading to the term "double deflation."

The practice of double deflation makes some operational compromises with the principles described above. Although producer price indices are the logical source of data for double deflation, PPI compilation systems do not provide ideal information for this purpose in all countries. The *1993 SNA* recommends compilation of a comprehensive system of output and input indices for production, but PPI programs are generally designed first to produce deflators for gross sales, and, accordingly, are compiled using "basic prices," as defined by the *1993 SNA*, which exclude taxes and invoiced transport margins. Strictly speaking, deflation of costs requires a system of industry input price indices, which are compiled in PPI systems less often. Input PPIs would require the *SNA's* "producer's prices," which include indirect taxes net of subsidies but exclude refundable taxes such as the Value Added Tax (VAT).

In addition, PPIs are compiled as Laspeyres, rather than Paasche, indices in the interest of producing timely data. Standard practice, when deflation methods are used for construction of constant price value added, is to deflate detailed current price industry aggregates with the detailed Laspeyres indices, produce higher-level constant price value added aggregates by summation of these detailed data, and produce the deflators for higher level aggregates by dividing their current price values by the constant price values so derived. This procedure is equivalent to constructing a Paasche index of detailed Laspeyres indices.

(2) Single indicator

The *1993 SNA* prefers the double deflation methodology for calculation of constant price value added, but recognizes the sensitivity of this method to measurement error, and that the limited availability of data can make it infeasible. Single indicators are recommended when measurement errors cause instability in double deflation estimates, input price index

data are unavailable, and/or current price value added is unavailable (as, for example, is often the case when constructing quarterly accounts).

When current price value added by industry and corresponding price index data of sufficient quality are available, the single indicator technique deflates current price value added by industry using the corresponding industry gross output price index, or PPI. 1/ The implied assumption is that the fraction of value added in the value of gross output is constant from period to period.

If current price data are unavailable, they can be estimated using a method of extrapolating value added from a reference period using a value index. The latter would be constructed as an index of current price sales of enterprises in the industry, or, if these data are unavailable, as the product of a physical indicator, preferably a quantity indicator such as a detailed industrial production index, and a price index, preferably from the PPI compilation system. 2/ Under this extrapolation method, constant price value added would be produced by extrapolation of reference period value added by the physical indicator alone.

b. Coverage

The limitation of PPI coverage to the industrial and (in some cases) agricultural sectors leaves a large fraction of output in the service sector for which constant price value added must be estimated by methods other than

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1/ As long as value added by industry is positive, a reasonable assumption, it is possible to derive single deflator that depends directly on the prices of outputs and inversely on the prices of inputs. The economic concept for value added permitting construction of this deflator is the restricted profit function of Lau ("A Characterization of the Normalized Restricted Profit Function," Journal of Economic Theory 12, 1976, pp. 131-163) and McFadden ("Cost, Revenue, and Profit Functions," in M. Fuss and D. McFadden, eds., Production Economics: A Dual Approach to Theory and Applications, Vol. 1, Amsterdam: North-Holland, 1978). Among the assumptions permitting this derivation is that enterprises successfully maximize value added given the prices of inputs and outputs. While this may be questionable in transition economies, the results still provide useful guidance on the selection of formula and determination of price weights.

2/ This assumes that the price index is sufficiently reliable. There is some question whether the deficiencies of the WPIs of some transition countries make them less accurate than the implicit deflators produced as by-products of the industrial production index compilation systems. For example, see Annex IV for a note on a potentially serious problem with the formula for the index. The improvements in WPI methodology and basic data brought about as a result of ongoing technical assistance will be needed to develop PPIs of sufficient quality for their broad and reliable use as deflators for the production accounts of the Baltic countries, the Russian Federation, and the other FSU countries.

deflation. In most countries, PPIs cover mining, manufacturing, and often agriculture, but venture only marginally into the service sector. This clearly limits the scope for direct deflation in compilation of constant price value added and GDP at factor cost. Appendix VI provides the typical aggregate industrial categories identified in the Classification of Branches of National Economy (CBNE) commonly used in the Baltic countries, the Russian Federation, and the other FSU countries, and some of their approximate correspondents in the International Standard Industrial Classification (ISIC). It can be seen from this table that, of the CBNE categories, only Industry, and possibly Agriculture, would be covered by the typical PPI program. On the other hand, GDP data for 1992 recently compiled in the national statistical offices of these countries with the assistance of the OECD shows that the Industry category includes approximately 50 percent of GDP in a number of countries.

The industrial aggregates susceptible to direct deflation, while an important part of total output, therefore leave a significant fraction of output in the service sector for which other methods of estimating constant price value added, including deflation by labor and other input price indices and extrapolation by physical indicators, must be used. Because of its increasing importance as a contributor to GDP in many countries, the service sector is the subject of an intensive measurement effort worldwide.

3. Expenditure on GDP by institutional unit

GDP deflators can be built up using current expenditure aggregates and detailed price index data from the consumer and parts of the producer price compilation systems. Here, some suggestions can be offered, based on Fund technical assistance experience and the practice of several countries. For deflation of the national expenditure accounts, it is often the case that detailed price and wage information is taken and recombined for national accounts deflation purposes. Because of the circumstances surrounding price index compilation in market economies, most price indices are produced with the Laspeyres formula to minimize publication lags, and the need for very frequent updates of the index weights. As with constant price value added, the practical approach taken by national accountants has been to use, where appropriate, detailed Laspeyres index series from the CPI and PPI compilations for deflation of detailed national expenditure estimates. The various analytical expenditure aggregates are then

calculated in constant price terms by summation of these deflated detailed values. 1/ 2/

A suggested pattern of uses for CPI and PPI data in deflation of the expenditure accounts is given in Appendix VII. The CPI is, of course, the logical deflator for current price household consumption, and parts of certain other aggregates, including government consumption, investment in dwellings, and external trade in services. The use of deflation methods for some of the expenditure aggregates, such as merchandise exports, imports, and services trade; the construction components of fixed investment; the changes in stocks component of investment; and government consumption will also depend on the breadth of industry coverage and quality of data from the PPI program. Under the high inflation conditions prevailing in most transition economies, correct measurement of changes in stocks becomes critical, because the holding gain component of the change in the nominal value of stocks is not included in the *1993 SNA* change-in-stocks concept. Accordingly, the *1993 SNA* recommends using replacement cost accounting to eliminate holding gains from inventory change figures. Data from the monthly/quarterly PPI might be used for deflating monthly/quarterly additions to and withdrawals from inventory under replacement cost accounting. 3/

1/ The *1993 SNA* prefers the chain Fisher price index, if feasible, for deflation of current price GDP. The U.S. Bureau of Economic Analysis is now undertaking compilation of annually chained Fisher Ideal alternative deflators for the U.S. national accounts. As in the present "Paasche" deflators, these indices will be a recombination of detailed Laspeyres indices from the CPI and PPI compilation systems.

2/ It should be noted that for the final expenditure components typically deflated with PPIs, the indices should be compiled using purchasers', in addition to basic, prices. In this connection, the *stage of processing* indices produced by a number of countries help to approximately identify industries whose sales are predominantly to final purchasers, and for which PPIs might usefully be developed in both basic and purchasers' prices.

3/ A standard methodology is to first deflate both end of period and beginning of period stocks by appropriately weighted indexes of detailed price data from the PPI and CPI compilation systems. The resulting deflated beginning of period stock is subtracted from the end of period stock to produce a change in stocks estimate in constant prices. Current price change in stocks is estimated by "reflating" the constant price stock change by a period average price index. The purchasers' prices/basic prices distinction is in principle important in the deflation of changes in stocks. Additions to and withdrawals from stocks of materials inputs should be deflated by an *input* PPI, at purchasers' prices, while additions to and withdrawals from stocks of finished goods should be deflated by an *output* PPI, at *basic* prices. The importance of this distinction increases with the nonrefundable indirect tax burden faced by the purchasing enterprise.

IMF Technical Assistance Missions on CPI Methodology in Transition Countries

Region	Country	Dates (M=Multitopic mission)
Europe	Albania	November 4-November 25, 1991 January 20-February 5, 1992 November 9-November 18, 1992
	Bulgaria	January 17-January 26, 1995
	Macedonia	January 10-January 26, 1995
Former Soviet Union	Armenia	April 29-May 11, 1993 October 15-October 30, 1993
	Azerbaijan	November 24-December 10, 1992 M April 9-April 19, 1993 October 4-October 14, 1994 M
	Belarus	October 19-October 30, 1992 February 15-February 26, 1993 April 13-April 22, 1993 M July 19-July 30, 1993
	Estonia	March 4-March 18, 1992 M June 1-June 11, 1992 August 2-August 18, 1992 October 11-October 19, 1993
	Georgia	November 4-November 18, 1992 M April 20-April 29, 1993 February 20-March 3, 1995
	Kazakhstan	August 27-September 13, 1992 M November 19-December 3, 1992 February 18-March 8, 1993
	Kyrgyz Republic	September 9-September 22, 1993 M March 18-April 1, 1994 September 14-September 27, 1994
	Latvia	March 16-April 24, 1992 M April 4-April 25, 1992 July 31-August 12, 1992 October 3-October 10, 1993
	Lithuania	March 16-April 3, 1992 July 20-July 29, 1992 September 13-September 18, 1993
	Moldova	April 13-April 28, 1994 M November 1-November 16, 1994 M

Region	Country	Dates (M=Multitopic mission)
Former Soviet Union	Russia	November 11-November 22, 1991 M
		February 17-February 28, 1992
		April 6-April 24, 1992
		May 25-June 11, 1992
		May 16-May 28, 1994
	Tajikistan	April 18-May 3, 1995
	Turmenistan	March 17-March 30, 1994
	Ukraine	May 18-May 30, 1992 M
	Ukraine (cont'd)	November 23-December 15, 1992 M
		April 12-April 23, 1993
		June 28-July 9, 1993
	Uzbekistan	July 6-July 20, 1993 M
		May 31-June 10, 1994
	Regional (Berlin)	April 30-May 7, 1993 M
Asia	Cambodia	June 15-June 28, 1995
	China	April 17-April 28, 1995
	Mongolia	March 18-April 1, 1991 M
		August 3-August 31, 1991
		September 28-October 8, 1991
		October 14-October 29, 1993 M
		June 17-June 30, 1995

IMF Technical Assistance Missions on PPI Methodology in Transition Countries

Region	Country	Dates M = Multitopic
Europe	Bulgaria	January 17-January 26, 1995
Former Soviet Union	Armenia	July 27-August 8, 1995
	Belarus	March 12-April 3, 1993 November 22-December 2, 1993
	Estonia	October 11-October 21, 1993
	Kazakhstan	April 24-May 5, 1995
	Russia	November 3-November 17, 1992 April 27-April 30, 1993 February 14-February 25, 1994 September 26-October 7, 1994
	Ukraine	April 12-April 23, 1993
	Uzbekistan	July 6-July 20, 1993 M
	Regional (Berlin)	April 30-May 7, 1993 M

CONSUMER PRICE INDEX MONTH/YEAR:

CITY/OBLAST/RAYON: _____ CODE:==========

ITEM: _____ Std. Qty 1/ Seas.2/ CODE:==========

OUTLET		PREVIOUS PERIOD					CURRENT PERIOD					C/P 3/
Code	NAME & ADDRESS	DAY	VARIETY	QTY 4/	PRICE		DAY	VARIETY	QTY 4/	PRICE		
					Collected	Converted				Collected	Converted	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)

Subtotal 1 _____ _____

Subtotal 2 (Event) _____ _____

Subtotal 3 (Event) _____ _____

TOTAL A _____ B _____

PRICE RELATIVE (B/A) ==========

1/ Standard Quantity 2/ Seasonal 3/ Col.12/Col. 7 4/ Quantity

Issues in Linking and Chaining Price Indices

Introduction

Two major issues arise in connection with linking price series as weighting information is revised from time to time. The first has to do with the exact methodology of performing a link when the weights of a Laspeyres index are periodically revised as new survey data arrives from households and/or enterprises. Generally this occurs with rather low frequency, from one to ten years in practice. Fund technical assistance missions have recommended annual updates for the Baltic countries, the Russian Federation and the other FSU countries. The second has to do with assessing the bias or "drift" induced by using index formulae other than the Laspeyres, given the price fluctuations and high inflation characteristic of the transitional environment. Of particular interest in this regard are formulae that effectively update the weights on some basis (not necessarily founded in new data) at high, monthly frequency. Use of a particular chain formula such as this has been encountered with some frequency in various parts of the world, but in particular in the Baltic countries, the Russian Federation, and the other FSU countries, where drift-inducing conditions are especially severe. This appendix deals with these two issues in turn within a framework developed in an important paper by Szulc (1983).

The general problem of linking Laspeyres index numbers

Fund missions have recommended discontinuing the Paasche formula used in a number of transition countries in favor of the Laspeyres, largely for operational reasons. Under the new private enterprise, market economy régime to which transitional economies direct themselves, the index compilers will no longer have the same immediate access to the detailed enterprise level data required for the Paasche index. Timely production of price statistics therefore requires a formula that makes less stringent information demands, leading to the Laspeyres approach, the effective world standard.

The Laspeyres index is given by

$$P_L^{0,t} = \frac{\sum_{i=1}^{n} p_i^t q_i^0}{\sum_{i=1}^{n} p_1^0 q_i^0} = \sum_{i=1}^{n} \left[w_i^0 \frac{p_i^{t-1}}{p_i^0} \right] \frac{p_i^t}{p_i^{t-1}} \qquad (1)$$

where

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

Use of the Laspeyres index still requires relatively frequent weight updates given the rapid structural changes undergone by transitional economies. Fund missions have recommended annual updates. The question arises how these new weights are to be linked into the ongoing price series?

Szulc's argument

Specializing Szulc's notation somewhat to orient toward the Laspeyres index, let

$$\begin{aligned} r_i^t &= \frac{p_i^t}{p_i^{t-1}} \\ y_i^t &= \frac{q_i^{t-1}}{q_i^0} \\ c_i^t &= w_i^0 \frac{p_i^{t-1}}{p_i^0} \end{aligned} \qquad (3)$$

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

We can then express the chain form of the Laspeyres index in equation (4) as:

$$P_L^{0,t} = \prod_{\tau=1}^{t} \frac{\sum_{i=1}^{n} c_i^\tau r_i^\tau}{\sum_{i=1}^{n} c_i^\tau} \qquad (4)$$

For comparison, we consider any chain index whose period to period links can be expressed as an average of short-term price relatives, and suppose that the weights are revised and a new link is introduced possibly every period. In this case (suppressing a couple of minor algebraic steps) we can express the chain index in terms of the cost weights of the Laspeyres index as:

$$P_C^{0,t} = \prod_{\tau=1}^{t} \frac{\sum_{i=1}^{n} c_i^\tau r_i^\tau y_i^\tau}{\sum_{i=1}^{n} c_i^\tau y_i^\tau} \tag{5}$$

Szulc defines the cumulative drift of the chain series relative to its "direct" Laspeyres counterpart as the ratio of (5) to (4), and applies a theorem of Bortkiewicz to show that the drift can be written

$$D^{0,t} = \prod_{\tau=1}^{t} \frac{\sum_{i=1}^{n} c_i^\tau r_i^\tau y_i^\tau / \sum_{i=1}^{n} c_i^\tau y_i^\tau}{\sum_{i=1}^{n} c_i^\tau r_i^\tau / \sum_{i=1}^{n} c_i^\tau} \tag{6}$$

$$= \prod_{\tau=1}^{t} (1 + corr(r^\tau, y^\tau)\, cv(r^\tau)\, cv(y^\tau)) \tag{7}$$

where $corr(r, y)$ refers to the correlation between r and y, and $cv(r)$ and $cv(y)$ refer to the coefficients of variation of r and y. (The cv is ratio of the standard deviation to the mean.) This 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 (7) depending on (cost-weighted) coefficients of variation (cvs), it can be inferred that highly variable and low to negatively correlated price and quantity movements across items for a given time period, because they increase the cvs of r and y, also increase the magnitude of drift, but do not affect its direction.

We are now in a position to analyze the drift in the Sauerbeck index. In any given period t, the "quantity weights" of the WAPR (weighted average price relative) generalized Sauerbeck index are proportional to the base period share weight divided by the price of the previous period, as

$$q_{WAPR,i}^{t-1} \propto \frac{w_i^0}{p_i^{t-1}} \qquad (8)$$

Conditional on the base period prices and quantities, then, 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 they share a common factor, a strong case can be made that r and y will be positively correlated across items in most situations, and hence the WAPR will drift upward relative to the Laspeyres. 1/ For the WAPR, positive correlation between r and y is implied by negative serial correlation in the short-term price relatives r. Similarly, a negative correlation between r and y is implied by a positive serial correlation in the short-term price relatives. 2/ Drift will be exacerbated by high own-variability and negative contemporaneous correlation between price relatives r across items, because they will increase the coefficient of variation in both r and y for the WAPR formula.

1/ Szulc points out that the Sauerbeck is consistent with the assumption of very strong substitution effects. From equation (8), this is also true of the generalized Sauerbeck/WAPR index. The correlation between percentage changes in p & q from the same time period for the same item is clearly -1.

2/ This may not be obvious from equations (7) and (8). Note that since

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

we can make an argument 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 relative to the Laspeyres. Using the same reasoning, we can argue that negative serial correlation in r will induce upward drift.

Implications for the practice of compiling price indices

The guidance equation (7) provides on linking is that the timing of a link should be such that there is a minimal correlation between the short-term price relatives for the current period, and the ratios of the quantities from the base period of the revision relative to the quantities from the earlier base period. For linked Laspeyres consumer price indices, because consumers tend to substitute away from items whose relative prices increase, a negative correlation is expected between prices and quantities collected from the same period. However, we would also expect that the larger the interval of time between the period in which the quantites are collected and the period of the prices, the smaller this correlation would be. This would lead to the expectation that the short-term price relatives r and long-term quantity relatives y would tend to be positively correlated, because the previous period prices in the *denominators* of the short-term relatives are closer in time (and therefore more highly negatively correlated with) the quantities of the revision period, which occur in the *numerators* of the long-term quantity relatives y. Introduction of revised CPIs by linking too close to the revision period may therefore induce an upward bias.

Following the same argument, we would expect linked Laspeyres producer price indices to be downward biased when revised series are introduced by linking too soon after the revision period.

Practically speaking, then, a revised index should be initiated from the revision period, but not linked to the existing series until the correlations between the prices of the link period and the quantities of the revision period have effectively died out. Interestingly, most statistical offices follow this practice, if only because the revision data arrive with a lag and they are reluctant to revise published series back to the revision period. For example, the U.S. CPI was most recently revised by updating the weights from 1972-73 to 1982-84, but the 72-73-based series continued until January 1987, when the revised series was introduced for publication and linked to the old series. The issue has arisen for Fund technical assistance missions because new CPI series have been constructed from historical data collected for existing price indicators prior to publication, opening the option of selecting a link date as close to the revision period as desired.

Before accepting the "aging" of a revised series prior to its introduction by linking, it should be noted that the link bias discussed here counteracts the substitution bias inherent in the Laspeyres formula, because it fixes the quantity and share weights of included items to their values in a base period. It is known that the Laspeyres CPI is upward biased from this source, and the Laspeyres PPI is downward biased. 1/

1/ On substitution bias, see Franklin Fisher and Karl Shell, The Economic Theory of Price Indices, New York: Academic Press, 1972.

Under the major and rapid structural changes occurring in the transition economies, it may be a reasonable tradeoff to accept some link bias in the interest of mitigating an arguably larger substitution bias from delaying the introduction of revised item weights. Fund technical assistance teams have generally judged in favor of early introduction of revised indices during the most tumultuous transition periods, which in the Baltic countries, the Russian Federation, and the other FSU countries began in January 1992 and continues, most recently somewhat abated depending on the country, to the present.

Potential bias arising from a common index formula in the Baltic countries, the Russian Federation, and the other FSU countries

A more serious chaining problem arises most often during the conversion from the Paasche methodology based on administrative data, to a Laspeyres CPI or PPI based on survey data. To date, the most significant cases of this problem have arisen in producer price measurement, but may also arise in compilation of the CPI. The indication of the problem is in a large inconsistency between one-month and twelve-month index changes, when both are purportedly based on a "fixed weight" methodology. The product of the eleven month-over-month indices for a given one-year interval will greatly exceed the direct twelve-month index. The analysis leading to this conclusion is, again, based in part on a seminal paper by Szulc, 1/ who studies the problem of drift for a wide class of index formulae, and in part on the observations of detailed price movements made by the Fund's technical assistance missions on price statistics to the Baltic countries, the Russian Federation, and the other FSU countries. Greatest during the year 1992, the drift declines with slower rates of inflation, but remained important through 1993 for countries such as Russia, where monthly inflation has run well into the double digits.

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.

1/ Bohdan Szulc, "Linking Price Index Numbers," in W. E. Diewert and C. Montmarquette, eds, Price Level Measurement: Proceedings of a Conference Sponsored by Statistics Canada, Ottawa: Statistics Canada, 1983, 537-562.

The potential for bias from using the Sauerbeck formula is dramatically illustrated by Szulc's "bouncing" price relatives example, shown in the table below. 1/

Table IV.1: "Bouncing Price Relatives"

	Product Price in period:				
	0	1	2	3	4
A	1	2	1	2	1
B	2	1	2	1	2

In this case, the direct index is equal to 1 in period 4 and the chained index is equal to 2.44, a 144 percent drift over an interval of five periods. 2/

Linking nonfixed base indices can lead mechanically to a difference between the chained index and the direct index. In our case the chained index is the monthly WAPR PPI, and the direct index is the "corresponding month of the previous period" version of the PPI. The difference can be positive or negative depending of the path of item price changes. It should be emphasized that the difference between the annual change in the chained monthly index and that of its direct, corresponding month of previous year counterpart is not related to differences in weighting *per se*, to price collection, or to the introduction of new products. It is simply the measure of a drift of a certain type of chained index relative to the Laspeyres over the period under review.

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

2/ Szulc attributes this result to the fact that the correlation between price changes and quantity changes is negative (in fact equal to -1) for the Sauerbeck index, arising from the form of the implicit quantity weights, $1/p_{it-1}$. This is, of course, also consistent with the WAPR index whose implicit quantity weights are given in equation (8). It is probably clearer and more general to note that the correlation condition for drift in the Sauerbeck against the Laspeyres is inversely related to the type of serial correlation in the price relatives. Szulc's example displays substantial negative serial correlation in the short-term price relatives, and substantial upward bias is the result.

II. Assessment

The available evidence supports the presumption that the pattern of price changes in the Baltic countries, the Russian Federation and the other FSU countries in 1992 approximated conditions leading to an upward drift of the WAPR month to month chained index. They also indicate that the drift is large: the chained index overestimates inflation by about 100 percent in one year. The table below gives the results of the comparison of the WAPR index and the t/t-12 version of the PPI over the December 1991-December 1992 period for some transition countries.

Table IV.2: PPI in Selected Transition Countries 1/

(In percent change from December 1991 to December 1992)

	Russia	Kyrgyz Republic	Estonia
(1) WAPR index	+6,097	+4,131	+2,125
(2) t/t-12	+3,275	+2,002	+1,261
(1)/(2) Drift	1.84	2.01	1.63

More recent results for the Russian Federation show that, although the drift has diminished from its peak in December 1992, it is still quite significant. The table below shows the drift in column (1), the average monthly drift in column (2), and the average monthly price change in column (3). We can read it like this for March 1993: the annual drift is equal to 34 percent, the monthly drift to two percent per month that can be compared to an average monthly inflation of 20 percent during the last 12 months.

1/ In fact, drift is equal to [(1) + 100] / [(2) + 100] because lines (1) and (2) are percent changes.

Table IV.3: PPI in the Russian Federation

(In percent changes)

	Drift	Average Monthly Drift 1/	Average Monthly Price Change
	(1)	(2)	(3)
December 1992	0.84	0.05	34
January 1993	0.58	0.04	22
February 1993	0.40	0.03	20
March 1993	0.34	0.02	20
April 1993	0.36	0.03	21
May 1993	0.32	0.02	21
June 1993	0.32	0.02	19
July 1993	0.32	0.02	20

III. Conclusions

The first conclusion is that the generalized Sauerbeck index clearly should be rejected as a measure of producer price change, particularly under conditions of high inflation and negative serial correlation in short-term rates of price change. To use it under these conditions as a deflator for the value of output leads to underestimated growth (or, more precisely in the case of the Baltic countries, the Russian Federation, and the other FSU countries, to overestimated decline) in industrial production.

The second conclusion is that, although having some other conceptual shortcomings, 2/ the t/t-12 version of the PPI is definitely a better measure of inflation for the relevant period of one year. However, this index is, unfortunately, useless in trying to derive a consistent monthly time-series.

There are, therefore, two possibilities for an economist desiring monthly producer price indicators for the Baltic countries, the Russian Federation and the other FSU countries: use other figures based on quantities or volume of production if available, or wait for the national compilers to implement a Laspeyres PPI in cooperation with the IMF Statistics technical assistance missions.

1/ The monthly drift is equal to the (1/12)th power of the annual drift.

2/ For example, the base period, 0 in w_{i0}, is not consistent with the t-12 period in the price relative, p_{it}/p_{it-12}.

Modified EUROSTAT Household Commodity Classification

Code	Description
1 00	**Food**
1 10	**Bread and Cereals**
1 11	Rice products
1 12	Milled Wheat products
1 13	Bread
1 14	Other baked goods
1 15	Pasta
1 20	**Meat, poultry, and fish**
1 21	Meat and poultry
1 22	Fish
1 30	**Dairy products (excluding butter) and eggs**
1 31	Dairy products
1 32	Eggs
1 40	**Oils and fats (including butter)**
1 41	Butter
1 42	Oils and other fat products
1 50	**Fruit and vegetables**
1 51	Fruit
1 52	Vegetables
1 53	Potatoes
1 60	**Sugar, coffee, tea, condiments**
1 61	Sugar
1 62	Coffee and tea
1 63	Candy, preserves, and sweets
1 64	Salt, sauces, and condiments
1 70	**Beverages at home**
1 71	Non-alcoholic beverages
1 72	Alcoholic beverages
1 80	**Food and beverages away from home**
1 81	Restaurants
1 82	Cafes and bars
1 83	Staff canteens
1 90	Tobacco

Code	Description
2 00	**Clothing and footwear**
2 10	Clothing
2 11	Men's clothing
2 12	Women's clothing
2 13	Children's clothing
2 21	Clothing materials
2 31	Sewing, tailoring, and maintenance
2 40	**Jewelery, watches, and accessories**
2 50	**Footwear, including repairs**
2 51	Men's footwear
2 52	Women's footwear
2 53	Children's footwear
2 54	Repairs to footwear
3 00	**Rent, water, fuel, and power**
3 10	**Gross rent and water charges**
3 11	Rent
3 12	Maintenance and repair
3 14	Water
3 20	**Fuel and power**
3 21	Electricity
3 22	Gas
3 25	Heat
4 00	**Household goods**
4 10	**Furniture and floor coverings**
4 11	Furniture and fixtures
4 12	Carpet and other floor coverings
4 21	Household textiles
4 31	Major household appliances
4 40	**Tableware and utensils**
4 41	Dishes
4 43	Other tableware
4 45	Utensils
4 50	**Cleaning and maintenance products**

APPENDIX V

Code	Description
4 51	Cleaning products
5 00	**Medical care**
5 10	**Pharmaceutical products**
6 00	**Transportation and communication**
6 10	**Personal transportation**
6 11	Automobiles
6 12	Bicycles and motorcycles
6 13	Motor fuel
6 30	**Public transportation**
6 31	Urban
6 32	Interurban
6 40	**Communication**
6 41	Mail
6 42	Telephone and telegraph
7 00	**Recreation, Education, and culture**
7 10	**Recreational equipment and accessories**
7 11	Video and audio equipment
7 12	Photographic equipment
7 13	Sports equipment and miscellaneous
7 20	**Entertainment and culture**
7 21	Video, cinema, theatrical, and musical performances, and museums
7 30	**Books, newspapers, etc**
7 31	Newspapers, magazines, and books
7 40	**Educational fees**
7 41	Primary educational fees
7 50	**Writing equipment and supplies**
7 51	Notebooks, paper, pens, pencils, and miscellaneous
7 60	**Vacation travel**
7 61	Accomodations and tours
8 00	**Personal care and effects**
8 11	Personal care services
8 12	Personal care goods

PPI Coverage of ISIC and CBNE Industrial Sectors 1/
(Shaded area indicates core PPI coverage)

ISIC Tab.cat	ISIC Div/Grp/Clss	ISIC Description	CBNE Industry Catergory
C	10-14	Mining and quarrying	Industry
D	15-37	Manufacturing	
	401	Production, collection and distribution of electricity	
	011	Growing of crops; market gardening; horticulture	Agriculture
	012	Farming of animals	
	013	Growing of corps combined with farming of animals	
	014	Agricultural and animal husbandry service activities, except veterinary activities	
	02	Forestry, logging and related service activities	Forestry
	45	Construction	Construction
	60	Land transport; transport via pipelines	Transport and maintenance of roads
	61	Water transport	
	62	Air transport	
	63	Supporting and auxiliary transport activities; activities of travel agencies	
	64	Post and telecommunications	Communication
	9213	Radio and television activities	
G	50-52	Wholesale and retail trade; repair of motor vehicles and motorcycles and personal and household goods	Wholesale trade, retail trade, and catering
			Material supply
			Procurement
	72	Computer and related activities	Information
	015	Hunting, trapping and game propagation including related service activities	Other material production
	05	Fishing, operation of fish hatcheries and fish farms; etc	
	22	Publishing, printing and reproduction of recorded media	
	37	Recycling	
	9211	Motion picture and video production and distribution (CBNE puts distribution in trade)	

1/ Concordance based on OECD, National Accounts for the Former Soviet Union, OCDE/GD (92)175, Chapter 2. Gross output; and United Nations, International Standard Industrial Classification of All Economic Activities, ST/ESA/STAT/SER.M/4/Rev.3, Statistical Papers, Series M, No. 4.

PPI Coverage of ISIC and CBNE Industrial Sectors 1/
(Shaded area indicates core PPI coverage)

ISIC Tab.cat	ISIC Div/Grp/Clss	ISIC Description	CBNE Industry Catergory
	70	Real estate activities (residential only)	Housing services and public utilities
	402	Manufacture of gas; distribution of gaseous fuels through mains	
	403	Steam and hot water supply	
	90	Sewage and refuse disposal, sanitation and similar activities	
N	85	Health and social work	Health
M	80	Education	Education
	92	Recreational, cultural and sporting activities (exc. 9211, 9213)	Culture and art
	73	Research and development	Science
	65	Financial intermediation, except insurance and pension funding	Credit
	66	Insurance and pension funding, except compulsory social security	Insurance
L	75	Public administration and defense; compulsory social security	General administration
	91	Activities of membership organizations N.E.C	Private non-profit institutions (PNPIs) serving households
	65	Financial intermediation, except insurance and pension funding	Bank Service charge

1/ Concordance based on OECD, National Accounts for the Former Soviet Union, OCDE/GD (92)175, Chapter 2. Gross output; and United Nations, International Standard Industrial Classification of All Economic Activities, ST/ESA/STAT/SER.M/4/Rev.3, Statistical Papers, Series M, No. 4.

Table VI.1: Consumer and Producer Price Indices in the Construction of Constant Price Expenditure Accounts 1/

(Shaded areas indicate preferred method with current statistics, in light of current weaknesses in the WPI/PPI, and trade price/unit value indices).

Component	Subcomponent	Deflation		Extrapolation
		CPI/PPI	Other	
Household consumption		CPI		
Government consumption	Military	PPI, CPI	Wage index; Implicit deflators from industrial production statistics	Government employment and hours worked data
	Nonmilitary			
Gross fixed capital formation	Nonresidential structures	PPI - construction (if available)		Commercial construction activity indicators
Gross fixed capital formation	Producers durable equipment	PPI for producers durable equipment	PPI or implicit deflator for PDE from partner countries adjusted by exchange rate index; import price or unit value index for producers' durable equipment items	Industrial production index for producers' durable equipment; import volume for PDE.

1/ This table summarizes IMF technical assistance mission experience and synthesizes the following sources:

U. S. Bureau of Economic Analysis, "Annual Revision of the U. S. National Income and Product Accounts," Survey of Current Business, August 1993, pp. 9-51.

Central Statistical Office, "Sources and Methods, Third Edition," United Kingdom National Accounts, Studies in Official Statistics No. 37, 1985.

Ian Castles, "Section 4. Constant Price Estimates," in Australian National Accounts: Concepts, Sources, and Methods, Canberra: Australian Bureau of Statistics, Catalogue no. 521, May 1990.

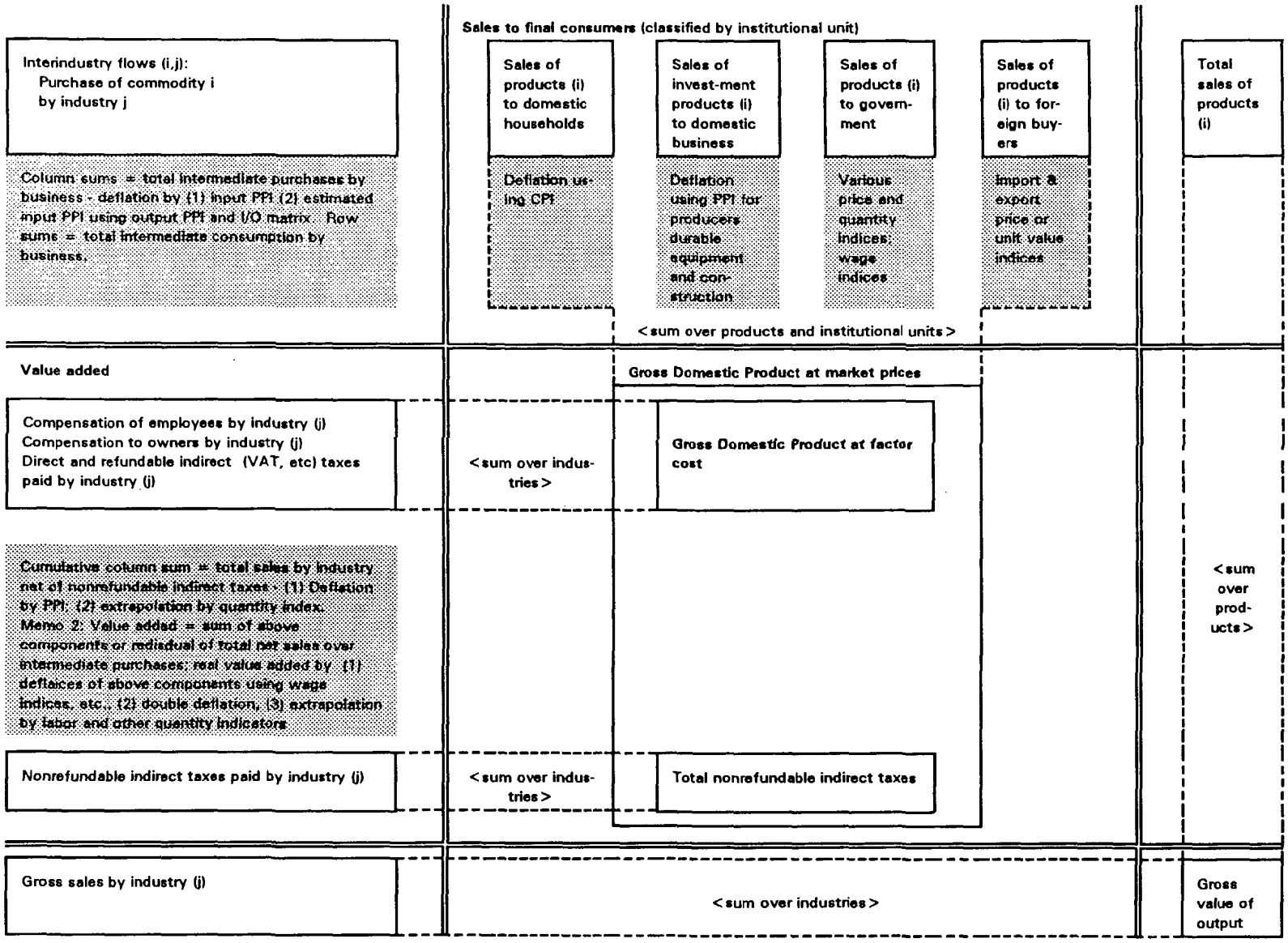
Further details on the use of both deflation and physical indicators methods for compiling real national accounts aggregates can be found in these references.

APPENDIX VII

Component	Subcomponent	Deflation		Extrapolation
		CPI/PPI	Other	
	Dwellings	CPI - Additions/ alterations CPI - durables PPI - equipment		Residential construction activity indicators
Changes in stocks	Nonfarm	PPI	Implicit deflators from industrial production statistics	
	Farm	PPI - agriculture (if available)		Agricultural production statistics
Exports of goods and services	Merchandise exports	PPI output price index stratified by domestic and exported sales (if available)	Implicit deflators from industrial production statistics; Export price or unit value indices;	
	Receipts for nonfactor services	PPI, CPI		
Imports of goods and services	Merchandise imports	PPI input price index stratified by domestic and imported purchases	PPI or implicit deflator from partner countries for specific imported items, adjusted by exchange rate index; Import price or unit value indices	
	Payments for nonfactor services	PPI, CPI	Partner country wage indices	

Table VI.2: Schematic Layout for Compiling Constant Price National Accounts Aggregates

Annotated for construction of real or constant price aggregates, primarily by deflation



References

Bradenkamp, Hugh, "Conducting Monetary and Credit Policy in Countries of the Former Soviet Union: Some Issues and Options," IMF Working Paper WP/93/23, (Washington: International Monetary Fund, March 1993)

Castles, Ian, "Section 4, Constant Price Estimates," in *Australian National Accounts: Concepts, Sources and Methods* (Canberra: Australian Bureau of Statistics, Catalogue no. 521, May 1990)

Central Statistical Office, "Sources and Methods, Third Edition," *United Kingdom National Accounts*, Studies in Official Statistics No. 37, 1985

Diewert, W. Erwin, "Superlative Index Numbers and Consistency in Aggregation," in *Econometrica*, 1978, p. 115-145

-----, "Exact and Superlative Index Numbers," *Journal of Econometrics* 4, 1976

-----, "On the Problem of Seasonal Goods" in *Price Level Measurement: Proceedings of a Conference Sponsored by Statistics Canada*, 1983

-----, and C. Montmarquette, eds, Price Level Measurement: *Proceedings of a Conference Sponsored by Statistics Canada*, 1983

Fischer, Irving, "The Making of Index Numbers," 3rd Edition (Boston: Houghton Mifflin, 1927, 1st Edition published in 1922)

Fischer, Franklin and Karl Shell, "The Economic Theory of Price Indices" (New York: Academic Press, 1972)

Hulten, Charles R., "Divisia Index Numbers," Econometrica 41 (6) (November, 1973, 1017-1025)

Koen, Vincent, and Steven Phillips, "Price Liberalization in Russia: The Early Record," IMF Working Paper WP/92/92, November, 1992, p.1

Konus, I.B., "The Problem of the True Index of the Cost of Living," translation of 1924 original appearing in *Econometrica 7*, 1939, 10-29

Kopits, George, "Lessons in Fiscal Consolidation for the Successor States of the Soviet Union," IMF Working paper WP/93/54 (Washington: International Monetary Fund, June 1993)

Lau, "A Characterixation of the Normalized Restricted Profit Function," *Journal of Economic Theory 12*, 1976

Lequiller, Francois, and Kimberly Zieschang, "Drift in Producer Price Indices for the Former Soviet Union Countries," IMF Staff Papers, Vol 41 No.3 (Washington: International Monetary Fund, September 1994)

McFadden, "Cost, Revenue and Profit FUnctions," in M. Fuss and D. McFadden, eds., *Production Economics: A Dual Approach to Theory and Applications, Vol.1* (Amsterdam: North-Holland, 1978)

Moulton, Brent R., "Basic Components of the CPI: Estimation of Price Changes," in *Monthly Labor Review*, by U.S. Bureau of Labor Statistics, Decmber, 1993)

Odling-Smee, John and Henri Lorie, "The Economic Reform Process in Russia," IMF Working Paper WP/93/55. (Washington: International Monetary Fund, July, 1993)

OECD, "National Accounts for the Former Soviet Union," OCDE/GD(92)175, Chapter 2

Reinsdorf, Marshall and Brent R. Moulton, "The Construction of Basic Components of Cost of Living Indexes," New Goods, T. Bresnahan and R.J. Gordon Eds. (National Bureau of Economic Research, 1994)

System of National Accounts 1993, *Inter-Secretariat Working Group on National Accounts*, (Brussels/Luxembourg-New York, Paris-Washington, D.C.: Commission of the European Communities/Eurostat-International Monetary Fund-Organization for Economic Cooperation and Development-United Nations, 1993)

Szulc, Bohdan, "Linking Price Index Numbers," in W.E. Diewert and C. Montmarquette, eds, *Price Level Measurement: Proceedings of a Conference Sponsored by Statistics Canada* (Ottawa: Statistics Canada, 1983)

Turvey, *et al*

United Nations Statistical Office, "Guidelines on Principles of a system of Price and Quantity Statisitcs," Statistical Papers series M, No. 59, 1977

UNSD, "Gross Output; and United Nations," *International Standard Classification of All Economic Activities*, ST/ESA/STAT/SER.M/4/Rev.3, Statistical Papers, Series M, No. 4

U.S. Bureau of Economic Analysis, "Annual Revision of the U.S. National Income and Product Accounts," *Survey of Current Business* (August 1993)

U.S. Department of Labor, Chapter 16: "Producer Prices," Bulletin 2414 in *BLS Handbook of Methods*, (Washington D.C.: U.S. Government Printing Office, 1992)