

Abstract of the Doctoral Dissertation

Measuring Price Dynamics of Scanner Products

The doctoral dissertation entitled ‘Measuring Price Dynamics of Scanner Products’ addresses the use of scanner data in inflation measurement and the development of methods for measuring price dynamics that are adapted to the specific characteristics of this data source. The development of electronic transaction systems and the ongoing digitalisation of retail trade make it possible to use detailed information on the actual prices and quantities of products sold in price statistics. At the same time, the high frequency of observations, substantial product turnover, and variability in prices and sales structures mean that scanner data require methodological solutions that account for their dynamic nature.

The main objective of the dissertation was to assess and develop methods for measuring the price dynamics of scanner products, with particular emphasis on the properties of multilateral versions of price indices and price and quantity indicators. This objective encompassed five interrelated research problems: assessing the potential use of scanner data in inflation measurement and identifying the limitations of bilateral indices; constructing a multilateral GEKS-type index that incorporates product quality matching; analysing the model-based approach to cost-of-living indices founded on the constant elasticity of substitution (CES) function; constructing a multilateral Montgomery indicator; and comparing the properties of multilateral Bennet and Montgomery indicators.

The research was conducted using actual scanner data from retail chains operating in Poland and covering a variety of food and non-food product groups. The datasets contained information on, among other things, product prices, sales quantities, transaction dates, store locations, labels, and product identifiers. The analyses included procedures for data cleaning, filtering, matching products over time, and classification, with particular attention paid to the effects of the level of aggregation and the data-filtering method on the results obtained.

The analyses demonstrated significant limitations of classical bilateral indices, including chain indices, under conditions of high product turnover and substantial variability in prices and sales quantities. Multilateral indices proved

better suited to the properties of scanner data because they account more fully for changes in the composition of the product basket. The values of the indices were also found to depend on the level of aggregation and the data-filtering procedures applied. Differences among the index estimates increased as the level of aggregation decreased, while the low-sales filter had a particularly strong effect on the results among the procedures considered.

An important outcome of the research was the development of a new multilateral price index, the GEKS-GAQI. This construction combines elements of the GEKS methodology with an approach based on product quality matching. The proposed index was shown to satisfy the stringent identity test while also allowing for product quality adjustment.

Another area of research concerned the use of scanner data within the economic approach to price-index construction based on the constant elasticity of substitution (CES) model. The estimates of the elasticity of substitution were shown to depend on both the level of data aggregation and the estimation method applied. Algebraic methods were more stable and less sensitive to data filtering and aggregation than approaches based on panel regression. An increase in the level of aggregation, in turn, led to a decrease in the estimated elasticity of substitution.

The dissertation also advances the methodology of price and quantity indicators. A multilateral, transitive version of the Montgomery indicator was proposed and shown to satisfy key axiomatic requirements even in the presence of unmatched products, missing data, and observations with zero prices. The multilateral approach also eliminates the problem of chain drift. A comparison of the transitive Bennet and Montgomery indicators showed that the differences between them decrease as the level of data aggregation increases. At the same time, the indicator values were confirmed to be highly sensitive to the filtering procedures applied, which, in extreme cases, may even reverse the sign of the resulting price and quantity effects.

The findings of the dissertation indicate that measuring price dynamics using scanner data is determined not only by the choice of an index or indicator formula, but also by decisions concerning data preparation, particularly aggregation and filtering. The contribution of the dissertation comprises the development of new methodological solutions, their empirical verification using actual transaction data, and the formulation of conclusions relevant to the

practice of modern price statistics. The research therefore contributes to the development of inflation-measurement methodology amid the growing use of detailed and dynamic data sources.

1.06.2026
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