On Measuring Aggregate Price Changes with Product Turnover

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Aggregation of prices or quantities when goods disappear or appear has been considered particularly challenging. Product turnover occurs at various aggregation levels. Frequent product turnover is observed in commodity-level scanner data. Various fresh foods, such as fruit, exhibit marked seasonal tendencies. Sometimes, we observe the disappearance of commodities at category levels, such as in the case of foreign trips during the COVID-19 pandemic. When we compare price levels across countries, we often encounter differences in product sets. In some countries, beef or pork is not consumed, while in other countries, such meats are quite popular. When commodity sets differ between two time periods, or across countries or regions, the current standard method used to construct the cost-of-living index, a price index number based on economic theory, is by Feenstra (1994). While the Feenstra index that accounts for various effects has been widely used, two problems remain. First, the Feenstra index is subject to chain drifts, which makes it difficult to compare price levels between two remote periods. The second problem is that the index cannot be defined when the elasticity of substitution is less than or equal to unity, which makes the index inapplicable for aggregation at the category level. In this paper, we propose a cost-of-living index that can be easily applied when product turnover occurs, which is free from chain drift, and that can be applied when the elasticity of substitution is small. Our proposed cost-of-living index can be applied when preferences vary over time or across regions. While Redding and Weinstein's (2020) recent proposal for a unified cost-of-living index can handle product turnover and preference heterogeneity, their index is subject to chain drift because product turnover is assumed to occur purely due to supply shocks. In contrast to the index of Redding and Weinstein (2020), which assumes *cardinal* utility, our index is based on *ordinal* utility. The assumption of ordinal utility enables us to consider product turnover caused not only by supply shocks but also by demand shocks. We will show that when the product turnover is

caused by demand shocks, the cost-of-living index is free from chain drift. We will also show that our index can be applied to price data at different levels of aggregation: from commodity-level scanner data to international comparisons above the elementary level. We also provide a procedure to decompose price changes due to demand and supply shocks. Our index exhibits notable differences from various indexes when applied to weekly scanner data. For example, in the case of ice cream for which there are strong seasonal trends in purchasing patterns and varieties, our index goes up during the summer, which makes the "real expenditures" on ice cream much smoother than the nominal expenditures, or other real expenditures deflated by Fisher's index, Feenstra's index, and the CUPI (CES-Unified Index) by Redding and Weinstein (2020). Furthermore, the CUPI and Feenstra's index show a strongly negative drift, while our index is transitive. Other applications of our index to national-level data are also provided, as are international comparisons.