The purpose of the comment on Asche, Bremnes, and Wessells (ABW) is to avoid confusion by professionals and policy makers regarding two things: inappropriate use of methodology and market definitions. The purpose of this reply is to do the same. There are two fundamental points raised by the comment: (1) the distinction between market integration and market efficiency and (2) appropriate methodology in testing for the Law of One Price (LOP). In the process of addressing these two points, we will clarify features of the international salmon market that provide us with valuable a priori information and address some of the other issues raised by the comment.

The comment states that ABW discuss market integration when they are actually testing market efficiency. We think that our use of the term market integration closely reflects the mainstream use of the term and is supported by the market definitions of Stigler, Cournot, and Marshall. All these market definitions are founded on the insight that in a perfectly integrated market, relative prices must be constant; i.e., the LOP must hold. This definition can also be found in more recent literature. For example, DeVany and Walls define market integration as cointegrated prices and define strong market integration as a situation where price shocks at any location in the spatial network must be reflected in all other location prices.1 DeVany and Walls statistically test this hypothesis of strong market integration with the null hypothesis that the cointegrating parameter β is equal to unity in a regression of one price on that of another, as does ABW, i.e., by testing for the LOP. Other recent articles using similar notions of market integration in different areas of economics include Centeno and Mello and Girma and Paulson.

Although no attention is given to it in the comment, a large part of ABW is concerned with aggregation. The LOP is not only consistent with market integration in Cournot, Marshall, and Stigler’s definitions, but also with the composite commodity theorem (CCP) by Hicks and Leontief. This suggests a link between market integration and aggregation. Because the LOP implies that relative prices between goods are constant, then one can aggregate the goods into a larger category which can be of great practical use in empirical studies. For example, if one wishes to study the salmon market, and export prices of Pacific salmon from the United States and Atlantic salmon from Norway move proportionally, then one can aggregate this into the generic category “salmon” and can thus conduct studies on the aggregated product. This is of interest for two reasons: (1) aggregated data may be the only data available for a particular empirical use; (2) the link between market integration, LOP, and CCP shows that several different economic theories are consistent with a proportional relationship between prices.

It is, however, certainly true that empirical data and relationships may measure something different from what one intends. McNew and Fackler and others who emphasize weaknesses with market integration tests spell out the mistakes that one can make. One can find statistical evidence of market integration when there truly is no market

---

1 This definition is easily extended to also take care of differences in product space as price proportionality is still the relevant criterion (see, e.g., Goldberg and Knetter who define market integration as the Law of One Price).
integration, and one may not find statistical evidence of market integration when there is both trade and spatial market efficiency, due to nonstationary transaction costs. The comment addresses both these issues, and although they are important issues in general, we do not believe either applies in ABW. First, it is possible to find cointegrated prices even when the underlying markets are not integrated if supply and demand shocks are cointegrated across regions.\(^2\) However, this requires an unusual set of circumstances that are not likely to be prevalent in the world’s salmon markets. Salmon is consumed in three primary markets, Europe, the United States, and Japan. These markets are different culturally. In addition, recent years have shown us that the business cycles are not highly correlated, as it took the three primary markets varying lengths of time to come out of the economic slowdown of the late 1980s. Other possible demand shocks may include events such as contamination or food poisoning, but events such as these have not occurred in the salmon markets. It is very difficult to conceive of shocks to demand that are common to all markets. On the supply side, most of the wild salmon is landed in the northern Pacific, and as such, one may argue that the strength of the stock sizes of each species may be related. However, each salmon species differs in the length of time they spend at sea before returning to their native streams. For example, pink salmon return every two years to spawn, while chum return in three to five years, and sockeye from four to six years. In addition, there is substantial variation in total landings of wild salmon from year to year. For example, total landings of salmon in the United States were 257,488 metric tons (mt) in 1997, 292,313 mt in 1998, and 369,634 mt in 1999. Changes in pink and sockeye landings contributed to most of that pattern of landings although, while pink salmon landings consistently increased, sockeye landings dropped in 1998. Farmed salmon has a completely different production technology from wild salmon. Supply shocks in world farmed salmon markets are likely to come from widespread onset of fish disease or unexpected and sudden changes in the price of feed. Thus, farmed salmon is highly unlikely to be affected by the same shocks as wild salmon.

Second, prices may not be cointegrated even if markets are spatially efficient due to the presence of nonstationary transportation or other transaction costs. However, ABW find that the LOP holds, which implies that the transaction costs must be stationary. This is supported by a priori knowledge that, while salmon is a perishable commodity, trade barriers other than those discussed in ABW are generally nonexistent, and transportation costs are small and relatively constant. This discussion shows that investigating price cointegration, market integration, and the LOP requires some a priori knowledge about the market in question.

The comment argues that the signs in table 2 of ABW are implausible and implies that this casts doubt on the value of the results. This would be true if one could interpret the parameters as in the comment. However, the cointegrating vectors in table 2 are only one representation of a multitude of potential representations, and thus economic interpretation is not possible. This is because cointegration vectors are identified only up to a nonsingular transformation (Johansen). Hence, additional normalizations or restrictions must be invoked to generate meaningful economic interpretations (Johansen and Juselius 1990, 1994). This is discussed on pp. 575–76 in ABW. With \(n - 1\) cointegration vectors, the multivariate system of equations can always be represented as bivariate relationships, as discussed in ABW. The advantage with a multivariate representation is that one can provide statistical tests of all the parameters in the system. However, for economic interpretation the cointegration vectors must be normalized so that they provide bivariate representations, as in equation (7) of ABW. These are the only representations that are economically interpretable because, with more than one price on the right hand side and given that the LOP holds for all prices, the estimated parameters for a multivariate representation will only be arbitrary weights, summing to one if the LOP holds.

The main advantage of conducting analysis on prices alone is that price data are often readily available while other data may not

\(^2\) It is also possible to find market integration, i.e., that the LOP holds, when the market is not efficient. This may occur in cases where there is collusive pricing by a spatial oligopoly. As Golberg and Knetter state: “However, a market that is integrated may or may not be perfectly competitive. A monopoly supplier of a commodity may charge a price above marginal cost, but be incapable of price discrimination if buyers are well organized or the product is easily transported across markets.” Neither of these cases exists in the world salmon market because of the multitude of suppliers, worldwide, which precludes collusive behavior.
be. When economists conduct studies of markets, in general, they may prefer to estimate demand and supply equations using prices and quantities produced and traded. However, for a number of products, quality data of a high frequency is available for prices, but not for quantities consumed (except perhaps on an annual basis). Prices do reflect the market equilibria of supply and demand and contain a richness of information by themselves. It is thus worthwhile to use analysis of prices, such as the equilibrium equations used in ABW, to learn more about the markets. Clearly, such analysis must be done correctly, with appropriate methodology and economic theory to guide the way. We believe that ABW has done exactly that, and that the policy implications resulting from the analysis are valid and valuable.

[Received October 2000; accepted January 2001]

References


