The export price index with the effect of variety and an empirical analysis ☆

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ABSTRACT

The standard international trade models predict that economic growth induces decreasing export prices. Korea has recorded sustainable economic and export growth, and its export prices have been deteriorating over the last decades. Unlike the standard assumption of one good per country, the new theoretical approach by Krugman [Krugman, P. (1980) 'Scale Economies, Product Differentiation, and Pattern of Trade'. American Economic Review 70, 950–959, Krugman, P. (1989) 'Differences in income elasticities and trends in real exchange rates'. European Economic Review, 33, 1055–1085.], and Helpman and Krugman [Helpman, E. and Krugman, P. (1985), Market structure and foreign trade: increasing returns, imperfect competition, and international economy, The MIT Press, Cambridge, MA.] takes into account varieties of goods produced in each country. And many studies suggest that traditional estimates without variety effect have been rather under-stated. Therefore this paper develops a proper modeling for quantifying the impact of export variety on an exact export price index. Throughout the period (1984–2000), the conventional export price index without variety effect leads to under-state Korea's export price by 89.3%. This paper shows that the fall in Korean export prices has been offset by the effect of export variety. This paper emphasizes the effect of export variety on international trade.

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1. Introduction

The Armington national differentiation model (1969) predicts that a larger economy produces larger quantity of each variety at a low price. The model by Acemoglu and Ventura (2002) shows that rich countries export higher quantity of each variety and face lower export prices, which leads to stable world income distribution. The standard model of trade flows implies that fast-growing countries with fast-growing exports should have decreasing export prices. Empirically, Korea has recorded sustainable economic as well as export growth over the last decades. As shown in Fig. 1, its export prices have been dramatically falling compared with the others, following the prediction of the standard Armington model (1969).

Unlike the standard assumption of a single good per country, the theoretical approach by Krugman (1980, 1989), and Helpman and Krugman (1985) takes into account varieties of goods produced in each country. The new trade model implies that fast growing countries can have fast-growing exports without a decline in the terms of trade. Recently, Hummels and Klenow (2005) find that if

exporting countries export more on extensive margins or higher quality, adverse terms of trade effects are no longer a necessary consequence. They show that economies with high per capita GDP export a wider set of goods (extensive margin), and larger quantities of good (intensive margin) at higher prices (high quality). Gagnon (2005) presents strong support for the new trade model in the long-run export growth of many countries in the post-war era. Fast growing countries need not experience declines in their terms of trade.

Subsequent research suggests that traditional estimates without considering variety effect have been under-stated or biased due to the omission. Particularly, welfare changes associated with trade liberalization are under-estimated. Romer (1994) models a small open economy importing intermediate goods. Compared to a 1% of GDP loss in the standard model, there is a loss of 10% in GDP in response to a 10% tariff. Feenstra (1994) and Hummels and Klenow (2005) show that the GDP-equivalent of welfare gains from greater import variety can be expressed as

$$(\text{Im port}/\text{GDP})(\text{Extensive M arg in})^{1/\sigma-1}$$

where σ is the elasticity of substitution between import varieties. Following this approach, Funke and Ruhwedel (2003) calculate welfare gains and then provide empirical evidence that the magnitude of variety gains from trade is somewhat limited. The research related to import demand suggests that import demand equations have been mis-specified due to the omission of product variety, and that price
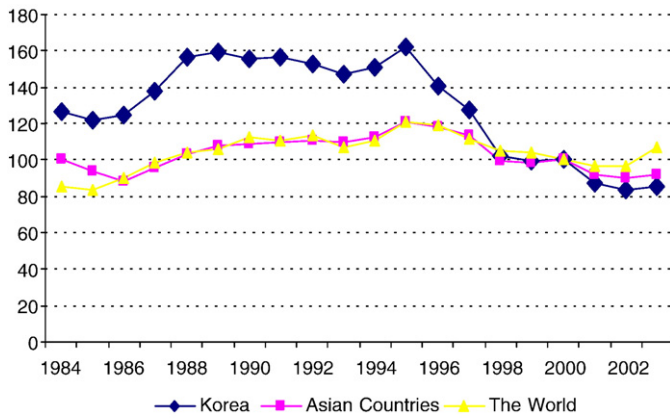
Note: Data source is IFS (2000=100).

Fig. 1. Export prices.

indices and income elasticities have thus been biased.[1] This paper develops a proper modeling for measuring the impact of export variety on an exact export price index. Using this framework, this paper evaluates the hypothesis that product variety of exports has helped to mitigate an adverse terms of trade effect induced by economic growth in Korea. The starting point is the seminal work of Feenstra (1994) and Broda and Weinstein (2006). This paper derives an exact export price index with a conventional export price index and the effect of variety. This paper sheds some light on the measure of export variety. The crude measure of export variety, the number of exported goods, has some drawbacks, so certain empirical studies have provided significant evidence of the growth in export variety by the methods benefiting from the work of Feenstra (1994)[2]. Many works on export variety[3] consider extensive margins for a cross-section of countries, comparing export variety from country to country. This paper constructs a measure of export variety by adapting Feenstra (1994, 2004) to compare export varieties from a country to its many destination countries. In order to calculate the conventional export price index, the Fisher (Tornqvist) export price index is developed from the ordinary Fisher (Tornqvist) method (Appendix). Measuring the adjustment effect of variety requires that the elasticity of substitution be estimated. Because of the simultaneous bias and measurement errors from using unit value instead of price, this paper adopts the Generalized Method of Moments, suggested by Feenstra (1994).

To quantify the effect of export variety on the exact export price index, I calculate the export variety and then estimate the elasticity of substitution between varieties. The estimated elasticity of substitution is used to evaluate the effect of variety. With the assumption that the elasticity of substitution is greater than one ($\sigma > 1$) in a CES preference, the fall in export prices is offset by export variety. Throughout the period (1984–2000), the conventional export price index leads to under-state Korea's export price by 89.3%. The result suggests

evidence for the theoretical claim that when the exact export price index is used, the fall in prices is smaller than when the conventional price index is used.

The paper is organized as follows. Section 2 derives an exact export price index with the effect of export variety. Section 3 presents an empirical strategy for estimating the elasticity of substitution. The generalized method of moment is suggested to correct for simultaneous bias and measurement errors. In Section 4, I discuss the data and then describe the measurement results for export variety, export price indices, and the elasticity of substitution. Section 4 also presents the impact of variety on the exact export price index. Section 5 concludes the paper.

2. The modeling

Following the ideas of Kang (2004b), this paper develops a monopolistic competition model with a CES preference and price index.[4] The preference in country c is

$$U^c = \left[\sum_{i \in I^{kc}} \left(q_i^{kc} \right)^{\frac{\sigma-1}{\sigma}} + \sum_{i \in \tilde{I}^c} \left(q_i^c \right)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \tag{1}$$

where q_i^{kc} is the consumption of good i imported from country k and q_i^c is the consumption of good i domestically produced or imported from other countries. The goods are substitutes, and the elasticity of substitution between any two goods is greater than one ($\sigma > 1$). I^{kc} represents the set of imported goods from country k, $\tilde{I}^c$ represents the available set of domestically produced goods and all other imported goods, I^c ($= I^{kc} \cup \tilde{I}^c$) denotes the available set of goods for country c, and I ($= I^{kc} \cap \tilde{I}^c$) denotes the set of goods that are common in both the set of goods imported from country k and the set of domestically produced goods and all other imported goods.

The aggregate CES prices for all goods and for imported goods from country k in country c are

$$\Pi^c = \left[\sum_{i \in I^c} \left(p_i^c \right)^{1-\sigma} \right]^{\frac{1}{1-\sigma}}, \text{ and } \Pi^{kc} = \left[\sum_{i \in I^{kc}} \left(p_i^{kc} \right)^{1-\sigma} \right]^{\frac{1}{1-\sigma}} \tag{2}$$

where p_i^c is the price of good i available in country c, and p_i^{kc} is the price of good i imported from country k.

This paper modifies Feenstra (1994)'s exact price index in which there are different varieties in the two periods.[5] As in the above two-part utility function, there are different varieties in the two sets, the set of imported goods from country k (I^{kc}) and the set of domestically produced goods and all other imported goods ($\tilde{I}^c$). The ratio of the CES functions over the two sets of goods in country c equals the product of the Sato-Vartia index of goods that are common, $I = (\tilde{I}^c \cap I^{kc}) \neq \emptyset$, multiplied by the terms reflecting the expenditure share of unique goods. If $I = (\tilde{I}^c \cap I^{kc}) \neq \emptyset$, then the exact price index with difference in varieties is given by,

$$\frac{\Pi^{kc}}{\Pi^c} = \prod_{i \in I} \left(\frac{p_i^{kc}}{p_i^c} \right)^{W_i(I_t)} \left(\frac{\lambda^{kc}(I^{kc})}{\lambda^c(\tilde{I}^c)} \right)^{\frac{1}{\sigma-1}}, \quad k, c = 1, \dots C. \tag{3}$$

[1] Sato (1977), and Helkie and Hooper (1988) use import demand equations that augment the price and income terms with a measure of exporter potential output, such as manufacturing capacity and capital stock, to reflect the effect of product variation. Feenstra and Shiells (1997) find that the income elasticity for US import is reduced from 2.5 to 2.2, and that the aggregate import price index is upwardly biased by between 1 and 2 % annually. Recently, Gagnon (2003) analyzes U.S. import demand from different source countries and find strong evidence of a supply effect of roughly half the magnitude (0.75) of the income elasticity (1.5). He shows that the exclusion of supply effect leads to over-estimation of the income elasticity.
[2] Feenstra (1994) derives the exact price index from the CES unit cost function, allowing for the new product varieties and taste or quality change. The introduction of new or upgraded product varieties lowers the exact price index. Broda and Weinstein (2006) extend this to all US imports.
[3] Feenstra et al. (1999a,b), Funke and Ruhwedel (2001a,b), Hummels and Klenow (2005), Kehoe and Ruhl (2002), Feenstra and Kee (2003).

[4] The model with the constant elasticity of substitution utility function is based on the Spence (1976), and Dixit and Stiglitz (1977) framework in which a representative consumer loves many varieties of the differentiated good ('love of variety').
[5] Sato (1976) and Vartia (1976) show that the ratio of cost function can be evaluated using data on prices and quantities in two periods or two countries. However, Feenstra (1994) derives the exact price index from the CES unit cost function, allowing for new product varieties and taste or quality change. Feenstra (1994) identifies the conventional price index that ignores new and disappearing product varieties and the exact price index that incorporates changes in variety (See Appendix in Feenstra (1994) for the proof).