CESSA WP 2019-01

Gains from Trade due to Increased Variety in Mongolia

Enkhmaa Battogtvor
Craig R. Parsons

Yokohama National University

February 2019

Center for Economic and Social Studies in Asia (CESSA) Working Paper

Center for Economic and Social Studies in Asia, Department of Economics
Yokohama National University

Gains from Trade due to Increased Variety in Mongolia*

Enkhmaa Battogtvor
Department of Economics
Yokohama National University
battogtvor-enkhmaa-wg@ynu.jp

Craig Parsons
Department of Economics
Yokohama National University
parsons-craig-gj@ynu.ac.jp

Keywords: Gains from trade, Elasticity of substitution, Welfare effect of trade liberalization

Abstract:

Contributing to the vast literature of gains from variety (Broda and Weinstein, 2006), we estimated the welfare impact of the enormous imported varieties growth in Mongolia and found it to be considerably larger than that found in other country studies. Thus, our results show that from 1988 to 2015, the gains from variety were equal to 22 percent of Mongolia's GDP, or 0.8 percent annually. While estimating the gains from variety, we estimated 1390 elasticities of substitution exclusive to Mongolia using the most disaggregated data available for Mongolia.

Word Count: 6948

* We would like to thank Kiyotaka Sato, Eiichi Tomiura, Minako Fujio and Tsunao Okumura for their useful comments and suggestions on earlier drafts. This paper is an extension of Battogtvor`s doctoral dissertation. We also thank My Duong who served as a discussant for the paper which was presented at the East Asian Economic Association in Taiwan, Oct 27-28, 2018. All errors are the authors' alone. Parsons is the contact author.

I. **Introduction**

The paper estimates the comprehensive gains from variety for Mongolian economy during 1988-2015, following the seminal works by Feenstra (1994) and Broda and Weinstein (2006). Mongolia undertook serious economic reforms in 1990 after the collapse of the Soviet Union and suffered a long and dramatic process of transformation into the free-market economy, easing price controls, liberalizing domestic and foreign trade. The centrally planned economy, state-owned industries and banking systems were transferred to the private sectors. However, the economy is still in transition.

In this paper, the gains from increased variety for the more open Mongolian economy were estimated, using six-digit harmonized system (HS) product data, the most disaggregated data available for Mongolia. We estimated 1390 elasticities and with these elasticities, we constructed an exact price index to measure the welfare gains from variety growth. This method is consistent with the theory of monopolistic competition and is robust in empirical applications (Feenstra, 1994).

The results show that the welfare gain owing to newly imported varieties from 1988 to 2015 amounts to 22 percent of GDP, or 0.8 percent annually. This is a significant result considering the moderate annual gains from 0.1 percent (Broda and Weinstein, 2006) to 0.4 percent (Chen and Ma, 2012) that most studies show.

We contribute to the growing literature by providing a measure of Mongolia's welfare gain due to import variety from 1988 to 2015. This is the first such study to apply the methodology of Broda and Weinstein (2006) to calculate Mongolian gains from variety, thus we had two *motivations* in mind. First, by measuring Mongolia's gains from import varieties after the liberalization in 1990s, we provided supporting evidence favoring trade liberalization for developing countries. Second, we estimated elasticities exclusive to Mongolia using a highly disaggregated import data and these elasticities may be useful for other studies.

The rest of the paper is organized as follows. Section 2 reviews the gains from trade literature. Section 3 describes the data and reviews Mongolia's rapid import growth from 1988 to 2015. Section 4 reviews the model of Broda and Weinstein (2006). Section 5 explains the estimation strategy and gives a brief overview of the importance of elasticities of substitution. Section 6 reports the results of the analysis and presents the welfare gains. Section 7 concludes.

1. Gains from Trade Literature

In the core of the monopolistic competition model with differentiated goods pioneered by Dixit and Stiglitz (1977), consumers and producers benefit from having more varieties of final goods and intermediate inputs, respectively. However, most studies focus on the conventional sources of gains, such as productivity improvement as a result of increasing returns of scale, trade-induced innovation, technology spillovers, and improved market efficiency because of import competition (Chen and Ma, 2012). These studies often assume a constant set of products over time and this leads to systematically understated welfare gain calculations.

The quantitative analysis of gains from variety starts with the seminal work of Feenstra (1994). Feenstra (1994) showed how to estimate the elasticities of substitution of individual products, and to incorporate these elasticities into a formula for an exact price index which he derived that can account for entry and exit of varieties. By doing so, Feenstra (1994) demonstrated that new product varieties lead to an increase in consumer utility. However, a comprehensive measure of the gains from import variety for an entire country puts tremendous demands on data availability and was not realized until Broda and Weinstein (2006).

Applying Feenstra's estimation technique Broda and Weinstein (2006) estimated the welfare gain that the US enjoyed through trade liberalization over the past 30 years by computing the elasticities of substitutions of more than 30,000 products. Using these elasticities, they created the import price index adjusted for new and disappearing varieties and measured the value that consumers attached to these new product varieties. They found that the total gain from the introduction of new varieties in the U.S. was 2.6 percent of GDP between 1972 and 2001. Strictly speaking, this means that in order to obtain the new set of varieties imported each year, consumers would be willing to pay on average 0.1 percent of their income.

Following Broda and Weinstein (2006), a body of country studies emerged, using the same methodology.[1] Chen and Ma (2012) found that the welfare gain in the Chinese economy as a result of new import variety amounts to 4.9 percent of GDP, or 0.4 percent annually between 1997 and 2008. Minondo and Requena (2010) investigated the welfare gains due to Spanish imports of new varieties over the period 1988-2006. They found that the total welfare gains were equal to 1.2 percent of GDP in 2006. In a comparative study of Switzerland and the U.S., Mohler (2009) estimated a lower and an upper bound of the gains from variety. He found that during the period from 1990 to 2006, the gains from variety in Switzerland were between 0.3 and 4.98 percent of GDP and that in the U.S. the gains from variety were between 0.5 and 4.7 percent of GDP. Mohler and Seitz (2012) applied the methodology to the 27 countries of the European Union for the period of 1999 to 2008. Their results show that within the European Union, especially "newer" and smaller member states exhibit high gains from newly imported varieties. For instance, Estonia gained 2.74 percent of its GDP, Slovakia 2.37 percent, Latvia 1.65 percent, Bulgaria 1.59 percent, and so on. They also found that interestingly, two of the

[1] Only a few of the many papers are mentioned here. In addition to its welfare gain estimation, Broda and Weinstein (2006) paper is often cited for its import demand elasticity estimates. Elasticity estimates of 73 countries (which does not include Mongolia) are available at Columbia University`s webpage: http://www.columbia.edu/~dew35/TradeElasticities/TradeElasticities.html

largest economies in the group, France and Germany, both had negative gains from variety. They argue that the reason for this is that these larger economies were already heavily integrated in the European economy and did therefore not experience the increase in product varieties as did the "new", smaller economies.

We contribute to the growing literature by providing a measure of Mongolia's welfare gain due to import variety from 1988 to 2015. This is the first study that pursues this measure for Mongolia, thus we have two *motivations* in mind as briefly stated in the introduction. First, as a small open economy, Mongolia underwent a drastic liberalization after the dissolution of the Soviet Union. The economy is now in transition. Thus, measuring Mongolia's gains from import varieties provides additional supporting evidence favoring trade liberalization for developing countries. Our findings may also provide informative implications for Mongolia's policymakers. Second, we obtain estimates for hundreds of elasticities of substitution using highly disaggregated import data of Mongolia, which may be useful for other future studies. For example, different elasticities may imply different responsiveness of imported products to demand shocks or exchange rate movements suggested by Chen and Ma (2012).

The definition of variety used in this paper is same as the variety defined in Broda and Weinstein (2006), which is an Armington (1969) definition of a product variety. By this definition, a variety is a particular good produced in a particular country. To be more specific, a product in this paper is defined as a six-digit HS good. To give an example, sparkling wine (with HS-6 product code 220410) was imported from only one country, Germany, in 1989. In sharp contrast to this, in 2015 wine was imported from 13 different countries such as France, Spain, Italy, Chile etc. As in Broda and Weinstein, we follow the Armington (1969) assumption, where an HS-6 product supplied by one country is regarded as a different variety as the same product supplied by another country.

Gains from increased import varieties are not limited to consumers. Access to more imported varieties may enhance productivity growth, leading domestic firms to gain substantially. In fact, with the widely used constant elasticity of substitution (CES) structure, new varieties could be modeled either as consumption goods or as intermediate inputs (Romer, 1994). We follow Broda and Weinstein (2006) and treat all imported goods as intended for final consumption.

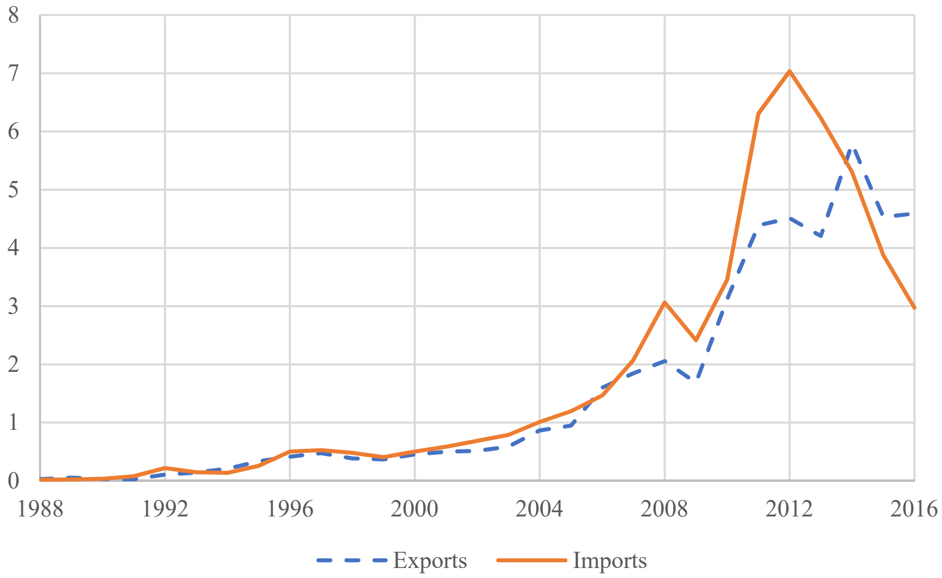
2. Data and Descriptive Analysis

We used the United Nations Comtrade - International Trade Statistics database for the trade data. The import data of Mongolia was not sufficient, lacking the years 2002, 2008-2012, 2015- 2016. Therefore, due to this data availability problem, we used the export data of rest of the world to Mongolia from 1988 to 2015, covering 28 continuous years. The data contains information on the total value, quantities and trading partner of registered product imports to Mongolia. When Comtrade had import data but reported the country of origin as 'Unspecified', that data point was dropped. Likewise, if there was 'Value' but no 'Quantity' of imports, that data point was also dropped. Furthermore, due to the insufficient numbers of varieties, HS-6 products with less than 37 observations were dropped.[2] This is due to the problem that many products were not imported to Mongolia constantly throughout the period. This left us with 158 thousand observations over 1628 products. Gross domestic product (GDP) data were taken from the World Bank Database.

To study the welfare implications of the drastic increase in imports of Mongolia, we should consider the increase in value of each product imported (i.e. the intensive margin) and the increase in the number of products and varieties for each product (i.e. the extensive margin).

[2] 37 is, of course, arbitrary. There were some HS-6 products with only a handful of observations which were dropped. 37 was a sort of natural cutoff where after that observations picked up rapidly.

Figure 1 *Exports and Imports (Billions of US Dollars)*



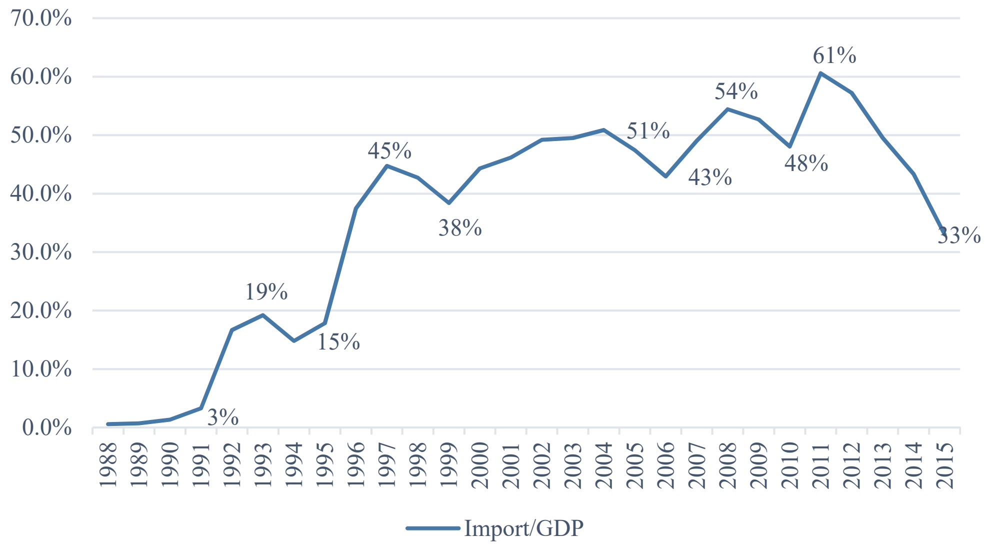
Source: The authors. Based on UN Comtrade data.

Mongolia undertook serious economic reforms in 1990 after the collapse of the Soviet Union and suffered a long and dramatic process of transformation into the free-market economy, liberalizing domestic and foreign trade. Figure 1 shows Mongolian foreign trade between 1988 and 2016. We can see that there was dramatic growth in the value of imports. According to our data, the value of imports was nearly zero in 1988 and gradually increased until peaking at seven ($7) billion dollars in 2012.

Figure 2 shows Mongolia's imports share of GDP between 1988 and 2016. The import share was almost zero in 1988. It gradually rose after the liberalization in 1990, and reached 45 percent when Mongolia became a World Trade Organization (WTO) member in 1997. By 2012, the share was 61 percent of GDP.[3] We can see an obvious rising demand for imports from Figures 1 and 2, and it demonstrates the importance of imports to Mongolian economy.

[3] However, as a result of the downturn in the economy and falling commodity prices, the share of imports of GDP in Figure 2.2, as well as its absolute volume in Figure 2.1, has dropped after 2012.

Figure 2 *Imports Share of GDP (%)*



Source: Authors' calculation based on import data from UN Comtrade and GDP data from the World Bank.

Table 1 summarizes the count measure of imported varieties of Mongolia between 1988 and 2015. The count measure is simply the number of varieties imported in each year, where the count of varieties, of wine, for example, was 15 in 2015. We can see that behind the rapid growth in import value was dramatic growth in import varieties (i.e. the extensive margin). Column (2) reports the number of HS-6 products for the related years. We can see that the number of these products increased by seven-fold during the period, from only 226 in 1988 to 1610 in 2015. Moreover, column (5) shows the total number of imported product varieties.

Table 1 *Variety in Mongolian Imports (1988-2015)*

	Year (1)	*Number of HS-6 products (2)*	*Median number of exporting countries (3)*	*Average number of exporting countries (4)*	*Total number of varieties (5)*
All 1988 goods	1988	226	1	1.1	255
All 2001 goods	2001	1512	3	3.5	5304
All 2015 goods	2015	1610	5	6.2	10052
Common, 1988-2015	1988	219	1	1.1	247
Common, 1988-2015	2015	219	3	8.0	1746
1988 not in 2015	1988	7	1	1.1	8
2015 not in 1988	2015	1391	3	6.0	8306

Source: Authors' calculation based on UN Comtrade data.

It can be seen from column (5) that the total number of varieties increased 40 times, from 255 to 10052. This is a remarkable increase that no other country study has ever shown. Columns (3) and (4) show the median and average number of source countries exporting to Mongolia, i.e. the number of varieties. We can observe that the number of exporting countries increased over time. In 1988 only one variety or source country was available per good, but in 2015 on average six varieties were available. The middle part of the Table 1 reports statistics of the common goods which were available in both the beginning and the end of the period. It is notable that, on average, these common products were imported from only one source country in 1988, however in 2015 the number of source countries rose to eight. The last two rows of the table show that there are 1391 new goods which were not available in 1988, imported from six different countries on average. These dramatic changes in goods and varieties suggest that conventional measures using a fixed basket of goods or varieties could be largely biased. Consequently, these facts demonstrate that the gains from variety are not negligible.

3. Methodology: the Broda and Weinstein Method

Following Feenstra (1994) and Broda and Weinstein (2006), we start by deriving an exact price index for a constant elasticity of substitution (CES) utility function of a single good with a constant number of varieties. This index is then extended by allowing for new and disappearing varieties. Finally, we show how to construct an aggregate import price index and gains from variety formula. Let us start with a simple CES utility function with the following functional form for a single imported good. Assume that varieties of a good g are treated as differentiated across countries of supply, *c*:

$$M_{gt} = \left(\sum_{c \in C} d_{gct} m_{gct}^{1-\sigma_g} \right)^{\frac{1}{(1-\sigma_g)}} \quad ; \sigma_g > 1 \qquad (1)$$

where *C* denotes the set of all countries and hence of all potentially available varieties. In the equation, m_{gct} is the subutility derived from the consumption of imported variety *c* of good g in period *t*; d_{gct} is the corresponding taste or quality parameter. The elasticity of substitution among varieties of good g is given by σ_g and is assumed to be larger than one.

Let $I_{gt} \subset C$ be the subset of all varieties of good g imported in period *t*. Using standard cost minimization for the sub-utility function (1) gives us the minimum unit-cost function:

$$\phi_{gt}(I_{gt}, \vec{d}_{gt}) = \left(\sum_{c \in I_{gt}} d_{gct} (p_{gct})^{1-\sigma_g} \right)^{\frac{1}{1-\sigma_g}} \qquad (2)$$

where p_{gct} is the price of variety *c* of good g in period *t* and $\vec{d}_{gt}$ is the vector of taste or quality parameters for each country.

Suppose the set of varieties I_g in period t and $t-1$ are identical, the taste parameters $\vec{d}_g$ are also constant over time and $\vec{x}_{gt}$ and $\vec{x}_{gt-1}$ are the cost-minimizing consumption bundle vectors for the varieties of good g for given the price vectors. In this case Diewert (1976) defines an exact price index as a ratio of the minimum cost functions:

$$P_g\left(\vec{p}_{gt},\vec{p}_{gt-1},\vec{x}_{gt},\vec{x}_{gt-1},I_g\right)=\frac{\phi_{gt}\left(I_g,\vec{d}_g\right)}{\phi_{gt-1}\left(I_g,\vec{d}_g\right)} \tag{3}$$

where the price index does not depend on the unknown taste or quality parameters d_{gc}. Sato (1976) and Vartia (1976) have derived the exact price index for the case of the CES unit-cost function. It can be written as the geometric mean of the individual variety price changes:

$$P_g\left(\vec{p}_{gt},\vec{p}_{gt-1},\vec{x}_{gt},\vec{x}_{gt-1},I_g\right)=\prod_{c\in I_g}\left(\frac{p_{gct}}{p_{gct-1}}\right)^{w_{gct}} \tag{4}$$

where the weights are calculated using the expenditure shares s_{gct}:

$$w_{gct}=\frac{\left(\frac{s_{gct}-s_{gct-1}}{\ln\ s_{gct}-\ln\ s_{gct-1}}\right)}{\sum_{c\in I_g}\left(\frac{s_{gct}-s_{gct-1}}{\ln\ s_{gct}-\ln\ s_{gct-1}}\right)} \tag{4.1}$$

$$s_{gct}=\frac{p_{gct}x_{gct}}{\sum_{c\in I_g}p_{gct}x_{gct}} \tag{4.2}$$

So far, it was assumed that all varieties of good g were available in both periods to calculate the exact price index. To include new and disappearing varieties into account, Feenstra (1994) showed how to modify this exact price index for the case of different, but overlapping, sets of varieties in the two periods. This contribution of Feenstra is given by the following proposition.

Proposition: For every good g, if $d_{gct} = d_{gct-1}$ for $c \in I_g = (I_{gt} \cap I_{g-1}), I_g \neq \emptyset$, then the exact price index for good g with change in varieties is given by

$$\pi_g(\vec{p}_{gt}, \vec{p}_{gt-1}, \vec{x}_{gt}, \vec{x}_{gt-1}, I_g) = \frac{\phi_{gt}(I_{gt}, \vec{d}_g)}{\phi_{gt-1}(I_{gt-1}, \vec{d}_g)} \tag{5}$$

$$= P_g(\vec{p}_{gt}, \vec{p}_{gt-1}, \vec{x}_{gt}, \vec{x}_{gt-1}, I_g)\left(\frac{\lambda_{gt}}{\lambda_{gt-1}}\right)^{\frac{1}{\sigma_g - 1}} \tag{6}$$

where

$$\lambda_{gt} = \frac{\sum_{c \in I_g} p_{gct} x_{gct}}{\sum_{c \in I_{gt}} p_{gct} x_{gct}} \quad \text{and} \quad \lambda_{gt-1} = \frac{\sum_{c \in I_g} p_{gct-1} x_{gct-1}}{\sum_{c \in I_{gt-1}} p_{gct-1} x_{gct-1}} \tag{7}$$

Feenstra's theoretical contribution is correcting the conventional price index $P_g(I_g)$ by multiplying it with an additional term which captures the influence of new and disappearing varieties. This additional term is called the lambda ratio. The numerator of this term, λ_{gt}, captures the impact of newly available varieties. λ_{gt} is the ratio of expenditures on varieties available in both periods (i.e., $c \in I_g = (I_{gt} \cap I_{g-1})$) relative to the entire set of varieties available in period t (i.e., $c \in I_{gt}$). Hence, λ_{gt} decreases when expenditure share of new varieties increases and therefore, the exact price index decreases relative to the conventional price index. On the other hand, the denominator of the lambda ratio, λ_{gt-1}, captures the impact of disappearing varieties. λ_{gt-1} increases when there are only few disappearing varieties, and therefore the exact price index is relatively low when compared to the conventional price index.

The exact price index also depends on the elasticity of substitution between varieties, σ_g. If σ_g is high, $\frac{1}{\sigma_g - 1}$ is close to zero and the additional term $\left(\frac{\lambda_{gt}}{\lambda_{gt-1}}\right)^{\frac{1}{\sigma_g - 1}}$ is close to unity.

Hence the variety change has small influence on the price index. This is intuitive, when σ_g is high since new and disappearing products are close substitutes to existing varieties, they only have a minor influence on the price index.

The exact price index with variety change for good g was derived in equation (6). Aggregating it for all imported goods *G* gives us the aggregate exact import price index:

$$\Pi(\vec{p}_t, \vec{p}_{t-1}, \vec{x}_t, \vec{x}_{t-1}, I) = \frac{\phi_t(I_t, \vec{d})}{\phi_{t-1}(I_{t-1}, \vec{d})} \tag{8}$$

$$= CIPI(I) \prod_{g \in G} \left(\frac{\lambda_{gt}}{\lambda_{gt-1}} \right)^{\frac{w_{gt}}{\sigma_g - 1}} \tag{9}$$

where $CIPI(I) = \prod_{g \in G} P_g(I_g)^{w_{gt}}$ and the weights w_{gt} are defined in equation (4.1). Equation (9) shows that the aggregate exact import price index is the product of the aggregate conventional import price index, CIPI(I), and the aggregated lambda ratios which is referred as an "aggregate bias" of the import price in Broda and Weinstein (2006).

The aggregate import bias, or simply the bias measure, is thus an indicator of an upward bias of the aggregate conventional import price index compared to the aggregate exact import price index. The ratio between aggregate exact price index including variety and the aggregate conventional price is as follows.

$$Bias = \frac{\Pi(I)}{CIPI(I)} = \prod_{g \in G} \left(\frac{\lambda_{gt}}{\lambda_{gt-1}} \right)^{\frac{w_{gt}}{\sigma_g - 1}} \tag{10}$$

Using a simple Krugman (1980) structure of the economy, the inverse of the bias can be weighted by the import expenditure share to get the gains from variety:

$$GFV = \left(\frac{1}{Bias}\right)^{w_t{}^M} - 1 = \left[\prod_{g \in G} \left(\frac{\lambda_{gt}}{\lambda_{gt-1}}\right)^{-\frac{w_{gt}}{\sigma_g - 1}}\right]^{w_t{}^M} - 1 \tag{11}$$

where $w_t{}^M$ is the import expenditure share in t.[4]

4. Estimation Strategy

Equation (9) implies that in order to compute the exact import price index we have to estimate the elasticity of substitution between varieties of each good. Therefore, in this section, we briefly review the estimator developed by Feenstra (1994) and improved by Broda and Weinstein (2006). After the review, using examples we explain the importance of the elasticities of substitution.

The estimation procedure allows for random changes in the taste parameters for imported varieties and is robust to measurement errors produced by using unit values. Given the utility function (1), the import demand equation for a specific variety using expenditure shares is as follows:

$$\Delta \ln s_{gct} = \varphi_{gt} - (\sigma_g - 1)\Delta \ln p_{gct} + \varepsilon_{gct} \tag{12}$$

where $\varphi_{gt} = (\sigma_g - 1) \ln \left[\frac{\phi_{gt}(d_t)}{\phi_{gt-1}(d_{t-1})}\right]$ is a random effect since d_t is random and $\varepsilon_{gct} = \Delta \ln d_{gct}$. The export supply equation is specified by:

$$\Delta \ln p_{gct} = \psi_{gt} + \frac{\omega_g}{1 + \omega_g} \Delta \ln s_{gct} + \delta_{gct} \tag{13}$$

[4] The import expenditure share $w_t{}^M$ is calculated as the share of imports in GDP in t. This is the separation point of our work from Broda and Weinstein (2006). To estimate the *overall* welfare gain, they used the ideal import share for their whole sample period, however they do not provide an estimation annually. In contrast to that, we estimate the welfare gain for *each year* in our sample period and as an overall gain, we simply take the summation. Refer to section 2.5.3 for details.

Where $\psi_{gt} = -\omega_g \frac{\Delta \ln E_{gt}}{(1+\omega_g)}$, $E_{gt} = \sum_{c \in C_{gt}} p_{gct} x_{gct}$ and $\omega_g \geq 0$ is the good specific inverse supply elasticity[5] (assumed to be constant across countries) and $\delta_{gct} = \frac{\Delta \ln v_{gct}}{(1+\omega_g)}$ is an error term that captures any random changes in a technology factor v_{gct}.

To identify the elasticity of substitution we can assume that the error terms between the demand and supply curve $(\varepsilon_{gct}, \delta_{gct})$ are uncorrelated after controlling for good and time specific effects. This means, demand and supply errors at the variety level are assumed to be uncorrelated, once good-time specific effects are controlled for. To take advantage of this assumption, we first eliminate the random terms φ_{gt} and ψ_{gt} from equations (12) and (13) by taking differences relative to a reference country k:

$$\Delta^k \ln s_{gct} = -(\sigma_g - 1)\Delta^k \ln p_{gct} + \varepsilon_{gct}^k \tag{14}$$

$$\Delta^k \ln p_{gct} = \frac{\omega_g}{1+\omega_g}\Delta^k \ln s_{gct} + \delta_{gct}^k \tag{15}$$

where $\Delta^k x_{gct} = \Delta x_{gct} - \Delta x_{gkt}$, $\varepsilon_{gct}^k = \varepsilon_{gct} - \varepsilon_{gkt}$ and $\delta_{gct}^k = \delta_{gct} - \delta_{gkt}$. Next, we multiply (14) and (15) and use the assumption of the independent error terms, i.e. $E(\varepsilon_{gct}^k \delta_{gct}^k) = 0$. As a result, we obtain the following:

$$\left(\Delta^k \ln p_{gct}\right)^2 = \theta_1 \left(\Delta^k \ln s_{gct}\right)^2 + \theta_2 \left(\Delta^k \ln p_{gct}\, \Delta^k \ln s_{gct}\right) + u_{gct} \tag{16}$$

where $\theta_1 = \frac{\omega_g}{(1+\omega_g)(\sigma_g - 1)}$, $\theta_2 = \frac{1-\omega_g(\sigma_g-2)}{(1+\omega_g)(\sigma_g-1)}$ and $u_{gct} = \varepsilon_{gct}^k \delta_{gct}^k$. However, there is a correlation between u_{gct} and the explanatory variables. To make the error term u_{gct}

[5] $\omega_g = 0$ is a special case of the export supply equation (13), where it is horizontal and there is no simultaneity bias, which is used for most of the empirical studies with gravity model to estimate the elasticity of substitution. However, stating $\omega_g \geq 0$, this study allows the export supply equation of variety *c* to vary with the amount of exports.

independent of the explanatory variables, the average of all variables over t are taken and denoted by upper bar:

$$\left(\overline{\Delta^k \ln p_{gct}}\right)^2 = \theta_1\left(\overline{\Delta^k \ln s_{gct}}\right)^2 + \theta_2\left(\overline{\Delta^k \ln p_{gct}}\,\overline{\Delta^k \ln s_{gct}}\right) + \overline{u_{gct}} \tag{17}$$

Using weighted least squares estimation, the estimates of θ_1 and θ_2 can be now consistent.

For each good g, the following objective function is used to obtain Hansen's (1982) estimator:

$$\hat{\beta}_g = \arg\min_{\beta \in B} G^*(\beta_g)' W G^*(\beta_g) \tag{18}$$

where $G^*(\beta_g)$ is the sample analog of $G(\beta_g)$, B is the set of economically feasible β such that $\sigma_g > 1$ and $\omega_g > 1$, and W is a positive definite weighting matrix. The optimal weights depend on the time span and import quantities (Broda and Weinstein, 2006). We estimate θ_1 and θ_2 and subsequently solve for σ_g. If the estimated σ_g is not economically reasonable, we use a grid search over the space defined by B. In this case, we follow Broda and Weinstein (2006) to compute the minimized GMM objective function over $\sigma_g \in [1.05, 131.5]$ at intervals which are 5 percent apart.[6]

Why Elasticities are Important?

An elasticity of substitution is a responsiveness (of the buyers) of a good to the price changes in its substitutes. Basically, it shows what happens to the relative demand when relative price changes between two goods. It is measured as the ratio of proportionate change in the relative demand for two goods to the proportionate change in their relative prices. In order to obtain estimates, we make several simplifying assumptions. Similarly, in order to value

[6] For a more detailed explanation refer to the working paper version Broda and Weinstein (2004).

varieties, we assume that we have only one or at most two elasticities of substitution, an assumption often made when using a utility function. This will implicitly assume the following (Broda and Weinstein, 2006). First, elasticities of substitution among varieties of different goods are the same. However, the same amount of increase in price of a variety of two different goods may be valued differently by consumers. For example, presumably consumers care more about varieties of computers than crude oil. So, in reality, all increases in imports do not give the same gains. Second, elasticities of substitution across goods equals that across varieties of a given good. However, it is likely that we care more about the different varieties of vegetables available than about the varieties of potatoes. Third, the largest problem arises from assuming that all varieties enter into the utility function with a common elasticity. For example, let's say Saudi Arabian oil prices went up. Then what will happen to our imports of Mexican oil? What will happen to our imports of automobiles? One should rise and the other should fall. The reason is that Mexican oil is an almost perfect substitute of the Saudi Arabian oil and cars are the complements. However, if we assume that the elasticities are equal, then it is very hard to interpret the meaning of the elasticity and there will be no intuition to its magnitude.

5. Results

In this section we discuss the results of our estimation of Mongolian welfare gains from an increased import product variety from 1988 to 2015. The estimation has four steps. First, following the estimation strategy in section 5, elasticities of substitution σ_g for each product are estimated. Second, we use equation (7) to calculate the lambda ratios λ_g for each imported product category. Third, with σ_g and λ_g, we obtain an estimate of the exact price index for each product after import variety change. Finally, using equation (9), we apply the log-change ideal weights to the price movements of each good in order to estimate the impact of variety growth on the aggregate import price index. Then with the knowledge of each year's aggregate import price index, using equation (11), we quantify the variety gains from trade with respect to GDP.

5.1 Elasticities of Substitution

We estimated equation (17) for each HS-6 product and obtained 1390 elasticities of substitution (henceforth, the 'sigmas'). Although it is impossible to report all sigmas, Table 2 presents the descriptive statistics of sigmas and Table 3 reports sigmas for the 20 products with the largest import share. By examining these tables, we can obtain a sense of the degree of substitutability among varieties. If sigma is high, say above 10 or 20, then this suggests that the potential for gains from variety, are small. When σ_g is high, since new and disappearing products are close substitutes to existing varieties, they will only have a minor influence on the price index and hence the gains from variety.[7] On the other hand, if sigma is low, then this suggests that goods are highly differentiated by country, meaning the potential for gains is high.

Table 2 *Estimated Elasticities of Substitution*

Statistic	*HS-6 level*
Percentile 90	12.1
Percentile 50 (Median)	3.6
Percentile 10	1.8
Mean	8.4
No of HS products	1390
Median variety per product	14

Note: Authors' calculation. See text for explanation.

Table 2 shows that the average elasticity of substitution is 8.4. and median is

[7] If we look at equation (6) and (9), it is clear that if σ_g is high, $\frac{1}{\sigma_g - 1}$ is close to zero and the additional term $\left(\frac{\lambda_{gt}}{\lambda_{gt-1}}\right)^{\frac{1}{\sigma_g - 1}}$ is closer to unity. Hence the variety change has small influence on the price index, when σ_g is high.

3.6.[8] Table 3 shows that products with the largest import share, save for one, have lower elasticities of substitution, which implies larger gains from variety.

Table 3 *Sigmas for the 20 Products with the Largest Import Share*

HS-6 products	*Sigma*	*Import share (%)*	*Descriptions*
271000	2.39	22.95	Petroleum Oils, Oils Obtained from Bituminous Minerals, Preparations Thereof
870323	1.44	2.33	Other Vehicles, Spark-ignition Engine Of a cylinder capacity exceeding 1,500 cc but not exceeding 3,000 cc
842952	1.20	1.33	Machinery With a 360degrees Revolving Superstructure
870410	24.63	1.33	Motor vehicles for the transport of goods Dumpers designed for off-highway use
870322	7.33	1.11	Other Vehicles, Spark-ignition Engine Of a cylinder capacity exceeding 1,000 cc but not exceeding 1,500 cc
870423	2.43	1.06	Motor vehicles for the transport of goods GVW exceeding 20 metric tons
110100	2.21	1.05	Wheat Flour, Meslin Flour
730890	8.69	1.02	Other Structures and Parts of Structures, of Iron or Steel
252329	5.04	1.01	Other Portland Cement
240220	2.90	0.94	Cigarettes (Containing Tobacco)
843149	3.39	0.81	Parts of Derricks, Cranes, Graders, Levelers, Scrapers or Pile-drivers
180690	5.06	0.78	Cocoa Preparations (In Containers, Packings, in Liquid, Powder, Granular Form)
847490	2.26	0.75	Parts of Machinery for Sorting, Crushing, Mixing, Molding or Shaping
300490	2.07	0.73	Other Medicaments (Put up in Packings for Retail Sale)
721420	17.22	0.72	Concrete reinforcing bars and rods, Hot-rolled, Hot-drawn, Hot-extruded
610462	5.78	0.70	Women's or Girls' Trousers, Breeches, of Cotton, Knitted or Crocheted
630221	3.71	0.66	Bed Linen, Printed, of Cotton
732611	4.11	0.59	Grinding Balls and Similar Forged or Stamped Articles for Mills
271320	3.26	0.58	Petroleum Bitumen
170490	3.12	0.55	Other Sugar Confectionery, Not Containing Cocoa

Source: Authors' calculation.

[8] As a reference results of Broda and Weinstein (2006) are as follows, mean is 17.3 in HS9, 7.5 in SITC-5 and median is 3.7 in HS9, 2.8 in SITC-5 in period 1972-1988 in US.

5.2 Change in Varieties

The second step is to calculate the changes in variety over time (i.e. the lambda ratio). The calculation of lambdas requires the existence of common varieties in the beginning and at the end of the period.[9] This is one of the major obstacles we face when implementing the technique. As a result, there are fewer lambda ratios than product groups or sigmas. Some lambda ratios cannot be defined at the HS-6 level since there is no common variety. We then follow Broda and Weinstein (2006) and define the lambda ratio at the HS-4 level.

Table 4 shows the summary statistics for the lambda ratios. The median lambda ratio is 0.96, expressing that the typical imported product category in Mongolia experienced a positive variety growth of about 4 percent[10]. Using the lambda ratios as a measure of variety growth is more sophisticated than just counting new and disappearing varieties. Due to the large number of new varieties with small market shares, just counting the new varieties can be misleading. This underscores the importance of carefully measuring variety growth when making price and welfare calculations. The measure also accounts for the importance of different varieties to the consumer budget decision by using expenditure shares as weights. The lower the lambdas the greater the varieties, and the more we spend on new varieties.

---

[9] The reason why we need common varieties is that we cannot value the creation and destruction of a variety without knowing something about how this affects the consumption of other varieties (Broda and Weinstein, 2006).

[10] Calculated as 1/0.96=4.2%.

Table 4 *Descriptive Statistics of Lambda Ratios*

Statistic	*HS-6 level*
Percentile 5	0.14
Percentile 50 (Median)	0.96
Percentile 95	4.78

Note: In here, due to the existence of outliers reaching high absolute values, the median is preferred to the mean.

5.3 Welfare Gain

Using the estimated elasticities of substitution and the lambda ratios, now we are ready to calculate the variety change effects on price. Following equation (9) by aggregating the lambda ratios gives the estimates of the impact of variety growth on the aggregate exact import price index. Table 5 reports the results of this exercise.

In column (4) of Table 5, the ratio of the aggregate exact price index including variety and the aggregate conventional price index is reported as the *bias* measure as in equation (10). It is worth explaining the intuition behind this bias. If this fraction is lower than one, it means that the changing set of imported varieties has *lowered* the import price index. In that case, the consumers benefit from lower unit costs of imports. Thus, these lower costs are the source of the welfare gains. On the other hand, if the bias is larger than one, this means that the import price index is *increased* by the changing variety set. Thus, the disappearing varieties are more valuable to the consumers than the new varieties and it results in welfare loss. Column (4) shows that in most years, the bias is lower than one, meaning the variety change resulted in lower import price index. On average, the bias measure is 0.978 which means that ignoring new and disappearing product varieties in the conventional price index had led to an upward bias of 2.25 percent.[11] This is the same thing as saying that import price inflation is overstated by 2.25 percent per year.

It is now time to calculate the welfare effect of the fall in the Mongolian exact import price. It should be noted that the welfare gain from this price fall is based on the functional forms assuming the Dixit-Stiglitz structure and cannot be general. Although our estimate of the impact of imported varieties on import prices is correct for any domestic production structure (Broda and Weinstein, 2006), it is not possible to translate this into a welfare gain without making explicit assumptions about the structure of domestic production. Following Broda and Weinstein (2006), our choice is to assume the same structure of the Mongolian economy as in Krugman (1980). There are two reasons for this. First, since Krugman's model is the dominant model of varieties, to understand the potential welfare gains, it provides a useful benchmark. Second reason is the lack of the necessary data and model of the economy's input-output linkages to estimate variants of the monopolistic competition model with more complex interactions between imported and domestic varieties.

Column (5) of Table 5 presents the gains from variety for every year between 1988 and 2015. The results show that in yearly basis, the welfare gain due to the increase in imported product varieties in Mongolia, accounted for average 0.8 percent of GDP. This means that a representative Mongolian consumer would be willing to give up 0.8 percent of her income to access the new import varieties every year. The welfare gains for the whole sample period from 1988 to 2015 is approximately 22 percent of the GDP and it is a remarkable result considering the moderate gains the most studies show.

---

[11] Calculated as $(\frac{1}{bias} - 1) \times 100$.

Considering the relatively high results of the welfare gain, we consider the following two reasons among many, to be important. First, as presented in section 3, the Mongolian import share of GDP is extremely high. In Table 5, Column (3) shows the import shares from 1988 to 2015. The import share rose significantly after 1996 and the average was 36 percent during the period. This is rather high compared to other studies. For instance, Broda and Weinstein (2006) found the ideal import share of the U.S.to be 6.7 percent for 1972-1988 and 10.3 percent for 1990-2001, respectively and Chen and Ma (2012) found the log-change ideal weight of China's import in GDP to be 11.5 percent during 1997-2008. Since we used the share of imports in GDP as a weight ${w_t}^M$ in equation (11), and the Mongolian import share of GDP is relatively high, the variety gain is consequently high.[12] Second and the main reason is that not only the growth in number of varieties was drastic, but also the growth in number of products was significant. Column (1) and (2) of Table 5 present the average number of varieties and number of HS-6 products, respectively. We can see that during the period, the number of varieties rose 6 times, from one to six, and on the other hand, the number of products rose 7 times, from 226 to 1610. This means that the numerator of the lambda ratios, λ_{gt}, which captures the impact of newly available varieties is low. Since λ_{gt} is the ratio of expenditures on varieties available in both periods (i.e., $c \in I_g = (I_{gt} \cap I_{g-1})$) relative to the entire set of varieties available in period *t* (i.e., $c \in I_{gt}$), evolving of the new variety decreases λ_{gt}. Hence, the exact price index is relatively low and the welfare gain is relatively high.

[12] Recall the results mentioned in section 2 (Mohler and Seitz, 2012) which found the gains from variety for Estonia to be 2.7%, followed by Slovakia (2.3%) and Bulgaria (1.57%). These transitional economies pale in comparison to Mongolia's experience.

Table 5 *Import Price Bias and the Gains from Variety*

Year	*Average number of varieties*	*Number of HS-6 products*	*Import share*	*Bias*	*Gains from Variety (%)*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*
1988	1.1	226	0.01	1.000	0.00%
1989	1.2	275	0.01	0.992	0.01%
1990	1.3	342	0.01	0.993	0.01%
1991	1.2	485	0.03	1.017	-0.06%
1992	1.4	783	0.17	0.911	1.56%
1993	1.6	791	0.19	0.888	2.32%
1994	2.1	1114	0.15	1.041	-0.60%
1995	2.5	1216	0.18	0.903	1.84%
1996	2.9	1408	0.37	0.811	8.14%
1997	2.9	1382	0.45	0.998	0.07%
1998	3.0	1398	0.43	1.011	-0.46%
1999	2.8	1410	0.38	0.973	1.06%
2000	3.3	1521	0.44	0.978	1.01%
2001	3.5	1512	0.46	0.942	2.79%
2002	3.5	1542	0.49	0.959	2.10%
2003	4.1	1579	0.50	0.966	1.75%
2004	4.3	1592	0.51	0.991	0.45%
2005	4.4	1573	0.47	1.009	-0.40%
2006	4.6	1601	0.43	1.036	-1.53%
2007	4.9	1587	0.49	0.957	2.17%
2008	5.1	1599	0.54	0.983	0.95%
2009	4.9	1601	0.53	0.993	0.36%
2010	5.7	1608	0.48	0.993	0.32%
2011	6.6	1611	0.61	0.981	1.18%
2012	7.1	1613	0.57	1.049	-2.68%
2013	7.7	1614	0.50	0.937	3.27%
2014	7.4	1616	0.43	1.027	-1.15%
2015	6.2	1610	0.33	1.058	-1.84%
Total (1988-2015)					22.63%
Average per-annum	*3.8*	*1293*	*0.36*	***0.978***	***0.81%***

Note: Authors' calculation based on six-digit disaggregated data from UN Comtrade. See text for detailed explanation.

6. Conclusion

There is a considerable amount of literature attempting to quantify the welfare gain of growing import variety. Thus, the importance of importing new varieties has been long-established. Moreover, the literature confirms that gains from trade varieties are in general much higher in developing countries than in developed countries. Mongolia is a small country that opened up in 1990s and has been in transition since. Compared to its size, the economy imports a great deal, spending on average 36 percent of the total expenditure in a year from 1988 to 2015. The economy has been gaining greatly from international trade. However, no comprehensive study exists on how much Mongolia gained from import variety growth.

We use highly disaggregated import data from 1988 to 2015 to estimate the elasticities of substitution for 1390 imported goods. These elasticities allow us to construct a comprehensive measure of the welfare gain using the seminal works by Feenstra (1994) and Broda and Weinstein (2006). The welfare gain due to growth in import varieties over the entire period amounts to 22.6% of GDP (or 0.8% annually). The welfare impact of import variety growth is remarkable are is much larger that studies of other countries.

The evidence from this chapter suggests that, especially for small and transitioning economies, the creation and extension of trade linkages can be an important source of increased welfare, a fact often neglected in the discussion about the positive effects of globalization and economic integration.

References

Armington, P. (1969) "A Theory of Demand for Products Distinguished by Place of Production" International Monetary Fund Staff Papers XVI, 159-78.

Broda, C. and D. E. Weinstein (2004) “Globalization and the Gains from Variety” NBER Working Paper 10314.

Broda, C. and D. E. Weinstein (2006) “Globalization and the Gains from Variety” *Quarterly Journal of Economics* **121**, 541–85.

Chen, B and H. Ma (2012) “Import Variety and Welfare Gain in China” *Review of International Economics* **20**, 807-20.

Diewert, W. E. (1976) “Exact and Superlative Index Numbers” *Journal of Econometrics* **4**, 115–45.

Dixit, A. K. and J. E. Stiglitz (1977) "Monopolistic Competition and Optimum Product Diversity" *American Economic Review* **67**, 297–308.

Eaton, J. and S. Kortum (2002) “Technology, Geography, and Trade” *Econometrica* **70**, 1741-79.

Feenstra, R. C. (1994) “New Product Varieties and the Measurement of International Prices” *American Economic Review* **84**, 157-77.

Hansen, L. P. (1982) “Large Sample Properties of Generalized Method of Moments Estimators” *Econometrica* **50**, 1029–54.

Helpman, E. (1981) “International Trade in the Presence of Product Differentiation, Economics of Scale and Monopolistic Competition: A Chamberlin-Heckscher-Ohlin Approach” *Journal of International Economics* **11**, 305-40.

Helpman, E. and P. Krugman (1985) *Market Structure and Foreign Trade: Increasing Returns, Imperfect Competition and the International Economy*. Cambridge, Massachusetts: MIT Press.

Klenow, P. J. and A. Rodriguez-Clare. (1997) “Quantifying Variety Gains from Trade Liberalization” Unpublished manuscript, University of Chicago, Berkeley.

Krugman, P. (1979) “Increasing Returns, Monopolistic Competition and International Trade” *Journal of International Economics* **10**, 469-79.

Krugman, P. (1980) “Scale Economies, Product Differentiation, and the Pattern of Trade” *American Economic Review* **70**, 950-59.

Krugman, P. (1981) “Intra-industry Specialization and the Gains from Trade” *Journal of Political Economy* **89**, 959-73.

Minondo, A. and F. Requena (2012) “Welfare Gains from Imported Varieties in Spain, 1988–2006” Instituto Valenciano de Investigaciones Económicas, S.A. (Ivie) Working Paper WP-EC2010-12.

Mohler, L. (2009) “Globalization and the Gains from Variety: Size and Openness of Countries and the Extensive Margin” University Library of Munich MPRA Paper.

Mohler, L and M. Seitz (2012) “The Gains from Variety in the European Union” *Review of World Economics*, 148 (3) 475-500.

Sato, K. (1976) “The Ideal Log-Change Index Number” *Review of Economics and Statistics* **58**, 223–28.

Stock, J. H., and M. W. Watson (2011) *Introduction to Econometrics*, Boston: Addison-Wesley.

Vartia, Y. O. (1976) “Ideal Log-Change Index Numbers” *Scandinavian Journal of Economics* **3**, 121–26.

Web page:

Columbia University

http://www.columbia.edu/~dew35/TradeElasticities/TradeElasticities.html