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Trade, Variety, and Immigration

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Trade, Variety, and Immigration*

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Abstract

What are the gains from international trade? And how do immigrants influence this process? While economists have considered these questions before, particularly in the context of aggregate trade flows, there has been no work assessing the relation between immigration and international trade in varieties—that is, the trade of particular goods from particular geographic areas. We consider the case of Canada, document its impressive experience with import variety growth in the period from 1988 to 2007, and relate this variety growth to the process of immigration. We find that import varieties grew 76%, that this growth is associated with a welfare gain as large as 28%, and that enhanced immigration flows may be responsible for 25% of this variety growth and its attendant welfare gains.

1. Introduction

At least since the time of Adam Smith, one of the fundamental questions in economics revolves around the gains from international trade. However, for all the clear-cut implications of the classical economists' models, the evidence is more ambiguous. In most instances, the gains from trade are shockingly hard to identify and surprisingly small in magnitude. But in recent years, the tide has turned as researchers have picked up this question again and sought to apply new techniques drawn from applications of consumer demand and index number theory. In particular, Broda and Weinstein (2006) have reawakened the profession's interest in the role of variety in enhancing consumer welfare, which was successively piqued with papers by the likes of Krugman (1979), Romer (1994), and Bils and Klenow (2001).

Their paper may best be thought of as a protracted and admirably detailed exercise in bringing the original work of Feenstra (1994) to the data. Building on Feenstra's insight that trade data could readily be used to trace the impact of new varieties on an exact price index of a single good, Broda and Weinstein (2006) extend this work to demonstrate that with a few reasonable simplifying assumptions, a similar methodology can be used to compute an aggregate price index for imported goods. Their results were dramatic: the bias introduced by not considering new import varieties in a standard import price index is on the order of 1.2% per year; cumulatively, this implies an unmeasured welfare gain to US consumers from international trade in the period from 1972 to 2001 representing 2.6% of GDP.

In this paper, we are able to contribute to this literature on two fronts. First, we exploit highly disaggregated Canadian trade data, especially with respect to the United States. Reflecting the unique relationship between Canada and the United States as the world's largest bilateral trading partners, Canadian agencies have consistently recorded import data not only on a very wide range of commodities, but also at the level of US states. Thus, we are able to employ a new working definition of variety which moves beyond the traditional taxonomy of a particular good from a particular country by considering subnational accounts. Perhaps not surprisingly, we are able to document higher rates of import variety growth, and hence, larger welfare gains than would potentially be the case by treating the United States as a single entity.

Second, we also seek to identify the sources of import variety growth. Two likely suspects present themselves in the form of economic growth and the reduction of trade costs. We draw from a long literature relating immigration to the growth of international trade via the reduction of trade costs. However, as a departure from this literature, we explicitly consider the role of immigration in fostering the growth of import varieties, arguing that immigrants are in a prime position to facilitate this process. Presumably, they possess superior knowledge of good varieties, market conditions, and regulatory environments in their home countries; potentially, they also face lower opportunity costs of engaging in import activity in the host country.

In sum, our results are that Canadian import varieties grew 76% from 1988 to 2007, that this growth is associated with a welfare gain as large as 28%, and that enhanced immigration flows may be responsible for 25% of this variety growth and its attendant welfare gains. In what follows, we first consider the data on variety growth in Section 2. Section 3 introduces our empirical strategy, which leans heavily on the work of Broda and Weinstein (2006). Section 4 lays outs our results with respect to the influence of import variety growth on implicit prices, and thus, consumer welfare. In section 5, we consider one potential source of this variety growth, namely immigration, while section 6 concludes with caveats and avenues for future research.

2. Data: Documenting Variety Growth

It almost goes without saying that Canada relies very heavily on international trade. And the most recent wave of globalization has deepened its engagement in international markets due to the reduction of trade and non-trade barriers and freer capital mobility. As a result, the share of imports in Canadian GDP has increased from 21.40% in 1988 to 27.55% in 2007.[1] However, in considering this rapid increase in import values, it is a generally underappreciated fact that the rate of increase in import varieties has been even greater.

We first need to clarify the definition of variety used in this paper. The ideal definition for a variety would be a market-based firm-brand such as the Honda Civic or Ford Focus. In several micro-level studies, researchers are able to use market-based survey data to study the effects of variety on welfare or productivity, e.g., Bloningen and Soderbery (2009). However, survey data is severely limited in terms of data coverage, usually comprising observations on a given industry for a few years at best. For better or worse, survey data cannot therefore be employed in macro-level studies, which require data on a much boarder scope, i.e., the entirety of tradable sectors of the economy. Researchers typically employ trade data organized along the lines of the Standard International Trade Classification (SITC) or Harmonized Commodity Description and Coding System (HS) to carry out macro-level studies and adopt the Armington definition that a variety is a country-good pair as in

1 Data are obtained from World Trade Analyser and CAMSIM unless otherwise stated.

Feenstra and Kee (2008). For example, beer produced in France and that produced in Britain are treated as two varieties of the product "beer."

In this paper, we follow this precedent with one important exception. Canadian statistics are unusually rich with respect to charting trade with the United States, given its overwhelming role in the Canadian economy. In this one particular case, it therefore becomes possible to define a variety as a state-good pair.[2] That is, we slightly abuse the standard definition of "variety" by treating each state as an independent exporting area. Again, treating the United States in such a manner is due to the dominant status of the United States in the Canadian import market. Though the US share of Canadian imports dropped from 66.36% in 1988 to 54.18% in 2007, the United States is still the overwhelmingly largest source of imports to Canada. By way of comparison, the second largest exporting countries to Canada were Japan in 1988 and China in 2007, with import shares of 7.06% and 8.82%, respectively.

We can justify this choice of treating state-good pairs as a variety in the following ways. First, if we were to treat the United States as a single country, it would significantly reduce the count of import varieties and would be equivalent to throwing away good data. Second and more importantly, it is very likely that large countries—such as the United States—do, in fact, produce multiple varieties of single goods. Take the example of wine imports into Canada from the United States. The sources range from obvious areas of production along the West Coast such as California, Oregon, and Washington

2 According to the data obtained from the World Trade Analyzer, we separate the United States into the following 54 exporting areas: Alabama, Alaska, Arizona, Arkansas, California, Colorado, Connecticut, Delaware, District of Columbia, Florida, Georgia, Hawaii, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Other Unspecified, Pennsylvania, Puerto Rico, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, United States Virgin Islands, Utah, Vermont, Virginia, Washington, West Virginia, Wisconsin, and Wyoming.

but also include Massachusetts, Michigan, and New York. Thus, treating large countries such as the United States as a single source of varieties likely understates consumer welfare gains significantly. But the likelihood of inducing such downward bias is reduced when we disaggregate the data to the provincial/state level. Indeed, the HS data (i.e., country/state–product level data) would converge to the ideal market-based data (i.e., firm/brand–level data) if they could be further disaggregated to the city level. In sum, we argue that treating individual states as separate exporting areas in Canadian imports is not only possible but also desirable.[3]

Table 1: Varieties in Canadian Imports (1988-2007)

	Reference year	Total number of HS categories (goods)	Median number of exporting areas per good	Average number of exporting areas per good	Total number of varieties (exporting area-good pairs)	Share of total Canadian imports (%)
	(1)	(2)	(3)	(4)	(5)	(6)
All goods, 1988	1988	12,072	20	24.1	290,726	100.00
All goods, 2007	2007	16,282	23	31.5	512,697	100.00
Common goods, 1988-2007	1988	4,207	20	24.4	102,666	25.34
Common goods, 1988-2007	2007	4,207	29	36.4	153,157	24.65
Goods present in 1988 but not in 2007	1988	7,865	19	23.9	188,060	74.66
Goods present in 2007 but not in 1988	2007	12,075	21	29.8	359,540	75.35

Source: Authors' calculation based on *WORLD TRADE ANALYSER*.

3 As should be clear in our empirical strategy, disaggregation to the state level does not mechanically increase the impact of variety on welfare even if it is argued that it "artificially" increases the count of varieties. What is important here is that the estimated elasticity of substitution across varieties is unbiased, regardless of whether or not varieties are defined at the national or sub-national level.

Based on our definition of varieties, Table 1 reports on varieties in Canadian imports between 1988 and 2007. In column (2), we document that the number of goods under HS definitions increased from 12,072 in 1988 to 16,282 in 2007 or by roughly one-third during these twenty years. At the same time, import varieties (exporting area-good pairs) increased from 290,726 in 1988 to 512,697 in 2007 or by more than three-quarters. These findings clearly show that imported varieties have increased much faster than imported goods as there are more countries competing in a typical goods market as suggested in column (3) and (4).

Additionally, column (2) shows that the number of goods in 1988 that still survived in 2007 was 4,207 or only one-third of the total goods in 1988 and one-quarter in 2007. That is, 7,865 goods from 1988 disappeared in the following twenty years whereas 12,075 new import goods entered the Canadian market by 2007. Similarly, column (5) shows that only 35% of the varieties in 1988 still survived in 2007 (=102,666/290,726) and that 70% of the varieties in 2007 are from new import goods (=359,540/512,697). Furthermore, column (6) shows that if measured in terms of shares of total imports, surviving import goods account for only about 25% of imports with the remaining 75% being accounted for by the appearance of new imports.

In sum, Table 1 reveals that working behind the rapid growth in imports, the growth in varieties has been even more dramatic. Furthermore, this growth has been accompanied by a huge turnover in import goods as fully two-thirds of the import goods and varieties in 1988 disappeared while many more entered the Canadian market by 2007, not only making up for the loss of disappeared imports but also contributing to the dramatic growth in imports. Finally, the dramatic change in goods and varieties also suggests that studies which limit their attention to a relatively fixed basket of goods and varieties, e.g., the consumer price index, may be inherently biased.

Table 2: Exporting Area's Rankings by Number of Goods Imported into Canada

Ranking in 2007	Exporting area	Number of varieties in 2007	Number of varieties in 1988
--	United States	15799	11815
1	China	11946	2894
2	US-New York	11009	9300
3	US-California	10792	7982
4	US-Illinois	10288	7689
5	Germany	10159	7122
6	US-Pennsylvania	9770	7502
7	US-Ohio	9669	7226
8	US-Michigan	9363	7296
9	US-New Jersey	9203	7728
10	United Kingdom	8846	6989
11	US-Texas	8670	5798
12	Italy	8657	5479
13	Japan	8643	5656
14	France	8564	5783
15	US-Washington State	8339	6291
16	US-Wisconsin	8283	5435
17	Taiwan	7925	4408
18	US-Minnesota	7669	5216
19	US-North Carolina	7562	4830
20	US-Massachusetts	7456	6179
21	US-Florida	7343	4806
22	US-Indiana	7316	4987
23	US-Georgia	7112	4583
24	Mexico	6926	1687
25	US-Missouri	6717	4457
26	India	6614	1412
27	Korea, South	6592	3484
28	US-Oregon	6502	4090
29	US-Tennessee	6285	4478
30	US-Other States	5973	7015

Source: Authors' calculation based on *WORLD TRADE ANALYSER*.

Columns (3) and (4) in Table 1 also show that the rapid variety growth is due to the increase in the number of areas exporting each good. To show this more clearly, Table 2 reports the exporting areas' ranking in both 1988 and 2007 with respect to the number of goods imported into Canada. Table 2 shows unsurprisingly that the US as a whole was the single largest source of import varieties for Canada in both 1988 and 2007. Also somewhat unsurprising is the fact that China vaulted in the rankings, jumping from fortieth in 1988 to first in 2007, provided that the US states are treated as separate exporting areas. Similarly, Taiwan, Mexico, and India register large improvements. Second, for all this improvement, fully 26 out of the top 30 countries in 2007 also made the list in 1988. And without exception, all these 26 countries are highly developed and have had longstanding economic ties with Canada dating from before World War II. The data in Table 2 are also consistent with three stylized factors which are believed to be the main forces driving the rapid growth in import varieties: the striking economic transformation of East Asia (e.g., China); the rapid fall in trade and nontrade barriers (e.g., Mexico); and enormous FDI inflows via vertical and horizontal integration (e.g., the United States and Japan) and FDI outflows via outsourcing (e.g., India).

Table 3 ranks the importance of countries according to their contribution to Canadian import-variety growth. Perhaps not surprisingly, emerging markets contribute the most in this respect: China in the first position is followed in order by Mexico and India. What is more, greater East Asia is playing a clear role in this process as fully 7 of the top contributing 10 economies are from this region. Finally, it is also worth noting that although traditionally important import-source areas did not contribute much in terms of import-variety growth, they are nevertheless the most important exporting areas with respect to the growth of Canadian import volumes. The rightmost column of Table 3 shows that with the exception of China, only the usual suspects—places like Germany, Japan, and the United States—have contributed more than 3% to Canadian import growth.

Table 3: Exporting Area's Contribution to the Growth in Canadian Import Varieties and Values, 1988-2007

Exporting Area	Percentage contribution to the growth in Canadian import varieties from 1988 to 2007	Average share in Canadian imports during 1988 to 2007*
China	4.08	3.87
Mexico	2.36	2.46
India	2.34	0.31
Taiwan	1.58	1.45
Italy	1.43	1.56
Thailand	1.42	0.44
South Korea	1.40	1.81
Germany	1.37	3.35
Indonesia	1.36	0.19
Japan	1.35	6.14
Viet Nam	1.32	0.07
Czech Republic	1.31	0.00
US-Texas	1.29	2.89
US-Wisconsin	1.28	1.97
US-California	1.27	3.86
France	1.25	1.95
Turkey	1.25	0.10
Spain	1.24	0.41
US-North Carolina	1.23	1.38
US-Illinois	1.17	4.54

Canadian import varieties are defined as HS good–country pairs.
(*) Defined as log ideal weights as in the text.

3. Empirical Strategy

3a. Modeling the Effects of Changes in Variety

Feenstra (1994) derives an exact price index for a constant elasticity of substitution (CES) aggregate good allowing for changes in both the variety and quality of existing goods. This index can also be used in the case of several goods or industries as long as they are CES aggregates. Broda and Weinstein (2006) extend Feenstra's price index to the case of several CES aggregates. As in Feenstra, they show that the bias imparted by ignoring new varieties depends on their relative share of consumption in those goods, the goods' weights in total consumption, and the elasticity of substitution between the varieties of these goods. The first two factors measure the importance of the new varieties in the consumption bundle. The last factor shows how much contribution a variety can make in improving welfare. When these elasticities are high—i.e., the varieties of the same good are easily substituted for one another—new varieties only make a small contribution to consumer welfare.

We follow Broda and Weinstein (2006) very closely in the following for expositional purposes—on this front, we make no claims to originality, but only summarize their work for the reader's reference. They begin by supposing that the preferences of a representative agent can be denoted by a three-level utility function. By doing so, one can differentiate the elasticities between varieties of the same good from those between goods separately. The upper level utility function is

$$(1) \qquad U(D_t, M_{1t}, \ldots, M_{N_t t}) = \left(\sum_{g \in G_t} \left(b_{gt}^{\frac{1}{\mathrm{g}}} M_{gt}^{\frac{\mathrm{g}-1}{\mathrm{g}}} \right)^{\frac{\mathrm{g}}{\mathrm{g}-1}} \right)^{1-\mathrm{a}} D_t^{\mathrm{a}} \; ; \; \mathrm{g} > 1$$

where M_{gt} is a composite imported good defined below in (2); D_t is the domestically produced good; g is the elasticity of substitution between imported goods; $G_t \subset \{1, \ldots, N_t\}$ is the set of imported goods at time *t*; and $b_{gt} > 0$ is a parameter representing the taste for good *g* which is allowed to vary over time *t*.

The composite imported good is defined as

$$(2) \qquad M_{gt} = \sum_{v \in V_{gt}} \left(d_{gvt}^{\frac{1}{\sigma_g}} \left(m_{gvt} \right)^{\frac{\sigma_g - 1}{\sigma_g}} \right)^{\frac{\sigma_g}{\sigma_g - 1}} ; \; \sigma_g > 1 \; \forall \; g \in G_t$$

where M_{gt} is the *nonsymmetric* CES subutility derived from the consumption of imported good *g* in time *t*; σ_g denotes the elasticity of substitution among imported varieties of the good *g*—this is assumed to exceed unity in order to guarantee that utility is concave over varieties; V_{gt} is the number of varieties of good *g* in time *t*; and *G* is the set of all imported goods. As in Feenstra and Kee (2008) as well as Broda and Weinstein (2006), we define a variety as a particular good originating from a particular country. Again, the United States represents the sole exception to this rule: in this case, we exploit the disaggregated nature of Canadian trade data and let a variety originating from the United States to be defined as a particular good originating from a particular state. In this case, V_{gt} is the number of exporting areas of good *g*. Finally, d_{gvt} denotes a taste or quality parameter for variety *v* of good *g*.

A minimum unit-cost function can be derived for the subutility function in (2) as

$$(3) \qquad c_{gt}^{M}(I_{gt}, d_{gt}) = \left(\sum_{c \in I_{gt}} d_{gvt} (p_{gvt})^{1-\sigma_g} \right)^{1/(1-\sigma_g)}$$

where p_{gvt} is the price of variety *v* of good *g* in period *t*; and $I_{gt} \subset V_g$ is the subset of all varieties of good *g* consumed in period *t*. The additive structure of the term in brackets clearly shows how conventional price indices fail to measure up under the love-of-variety approach. As Broda and Weinstein (2006) note, if d_{gv} equals one—i.e., M_g is symmetric—then in a standard monopolistic competition model all varieties will be equally priced at p_g and $c_g^M = I_g^{1/(1-\sigma_g)} p_g$. Therefore, for a given p_g, the minimum cost c_g^M is decreasing in I_g, which implies that the required cost to attain a given level of utility falls as variety increases. Such an effect from the introduction of new varieties is not captured in conventional price indices that are based only on common varieties.

A minimum unit-cost function can be derived for the utility function (1) as

$$(4) \qquad c_t^M = \left(\sum_{g \in G} (\phi_{gt}^M (I_{gt}, \delta_{gt}))^{1-\gamma} \right)^{1/(1-\gamma)}$$

while the overall price index is, in turn, given by

$$(5) \qquad p_t = [(p_t^D)^{1-\kappa} + (c_t^M)^{1-\kappa}]^{1/(1-\kappa)}$$

where the price of the domestic good is p_t^D. Equations (3) through (5) constitute the building blocks necessary for the calculation of exact aggregate price indices.

Based on the work of Feenstra (1994), we consider Broda and Weinstein's derivation of the aggregate bias generated by ignoring new varieties. Following Diewert (1976), an exact price index for good *g* over a constant set of varieties can be defined as

$$(6) \qquad P_g^M (\mathrm{P}_{gt}, \mathrm{P}_{gt-1}, \mathrm{X}_{gt}, \mathrm{X}_{gt-1}, \mathrm{I}_g) = \frac{c_{gt}^M (I_g, \delta_g)}{c_{gt-1}^M (I_g, \delta_g)}$$

where $I_g = I_{gt} \cap I_{gt-1}$ is the set of common varieties consumed in both time *t* and $t-1$; and taste parameters are constant over time, $d_{gvt} = d_{gvt-1} = d_{gv}$ for $v \in I_g$. In this case, $I_g = I_{gt} = I_{gt-1}$ as varieties are constant over time. X_{gt} and X_{gt-1} are the cost-minimizing quantity vectors of good *g*'s varieties given the prices of all varieties, P_{gt} and P_{gt-1}. As such a price index does not depend on the unknown quality parameters d_{gv}, the levels of consumption contain all of the available information on quality.

Sato (1976) and Vartia (1976) show that (6) can be expressed for the CES unit-cost function as

$$\text{(7)} \qquad P_g(\mathrm{P}_{gt}, \mathrm{P}_{gt-1}, \mathrm{X}_{gt}, \mathrm{X}_{gt-1}, \mathrm{I}_g) = \prod_{v \in I_g} \left(\frac{p_{gvt}}{p_{gvt-1}} \right)^{\mathrm{w}_{gvt}}$$

where the price index is a geometric mean of the changes in price of the individual varieties weighted by ideal log-change weights computed using cost shares s_{gc} in the two periods:

$$\text{(8)} \qquad s_{gvt} = \frac{p_{gvt} x_{gvt}}{\sum_{v \in I_g} p_{gvt} x_{gvt}}$$

$$\text{(9)} \qquad \mathrm{w}_{gvt} = \frac{(s_{gvt} - s_{gvt-1}) / (\ln s_{gvt} - \ln s_{gvt-1})}{\sum_{v \in I_g} ((s_{gvt} - s_{gvt-1}) / (\ln s_{gvt} - \ln s_{gvt-1}))}.$$

Note that in (7) P_g requires that all varieties be available in both periods. In the case that the sets of varieties are different but have some overlap in the two periods, Feenstra (1994) shows that for $\forall\ g \in G$ and provided that $d_{gvt} = d_{gvt-1}$ and $I_g \neq \varnothing$, the exact price index for good *g* with changes in variety is the following:

$$\text{(10)} \quad E_g(\mathrm{P}_{gt}, \mathrm{P}_{gt-1}, \mathrm{X}_{gt}, \mathrm{X}_{gt-1}, \mathrm{I}_g) = \frac{c_{gt}^M (I_g, \mathrm{d}_g)}{c_{gt-1}^M (I_g, \mathrm{d}_g)}) = P_g^M (\mathrm{P}_{gt}, \mathrm{P}_{gt-1}, \mathrm{X}_{gt}, \mathrm{X}_{gt-1}, \mathrm{I}_g) \left(\frac{\mathrm{I}_{gt}}{\mathrm{I}_{gt-1}} \right)^{1/(\mathrm{s}_g - 1)}$$

where $\mathrm{I}_{gt} = \frac{\sum_{v \in I_g} p_{gvt} x_{gvt}}{\sum_{v \in I_{gt}} p_{gvt} x_{gvt}}$ and $\mathrm{I}_{gt-1} = \frac{\sum_{v \in I_g} p_{gvt-1} x_{gvt-1}}{\sum_{v \in I_{gt-1}} p_{gvt-1} x_{gvt-1}}$.

Equation (10) states that the exact price index in the presence of changes in variety, E_g, is the product of two terms: the "conventional" price index defined over a common set of varieties, P_g^M, and the effect of changes in variety, $(\lambda_{gt}/\lambda_{gt-1})^{1/(\sigma_g-1)}$. Note that the ratio of lambdas is actually a measure of the change in variety weighted by the corresponding import revenue of each variety. If in the restrictive case where the revenue of each variety is identical, the change in variety, $\frac{\lambda_{07}}{\lambda_{88}} = \left(\frac{\sum_{v\in I_g} p_{gvt}x_{gvt}}{\sum_{v\in I_{gt}} p_{gvt}x_{gvt}}\right)\Big/\left(\frac{\sum_{v\in I_g} p_{gvt-1}x_{gvt-1}}{\sum_{v\in I_{gt-1}} p_{gvt-1}x_{gvt-1}}\right)$, corresponds to V_{1988}/V_{2007}, the simple ratio of the number of varieties in 1988 and 2007. In other words, the ratio of lambdas is in fact an inversed weighted growth in varieties. The higher the expenditure share on new varieties—i.e., the lower is λ_{gt}—the smaller is lambda ration and thus the smaller the exact price index relative to the conventional price index. Thus, an increase in variety results in a decline in the modified exact price index relative to the conventional price index. The magnitude of this decline depends on how important the new varieties are to consumers—that is, their consumption shares—and the similarity between new varieties and old ones, which is measured by the good-specific elasticity of substitution, σ_g. As σ_g approaches infinity, varieties are perfect substitutes for each other, in which case, $1/(\sigma_g-1)$ approaches 0, and the term $(\lambda_{gt}/\lambda_{gt-1})^{1/(\sigma_g-1)}$ approaches 1. On the contrary, when σ_g is close to 1, varieties are not close substitutes. In this case, $1/(\sigma_g-1)$ is high, and the effect of changes in variety becomes important as new varieties are very beneficial (while disappearing varieties are very costly in welfare terms). Finally, the weighted variety measure is also robust to splitting varieties (for example, from country-product pair to state-product pair). For example, assume wine is imported from two US states with equal shares. Then the count of wine varieties will increase by 1 as one country-level variety splits to two state-level varieties. However, the weighted variety measure will remain unchanged since the weight of each new variety also splits in a half. Nevertheless, this does not imply that more disaggregated varieties contain no additional information. Suppose wine was initially imported from only one US state, with two states following later. If we were to measure varieties only at country level, we may erroneously deem it is a common variety that the US exports in both periods. However, we can capture the variety change if measuring varieties at the state level.

Similar to the derivation of the exact price index for the subutility function in (2), the *aggregate* exact import price index for (1) can be derived as follows. If $I_g \neq \varnothing \ \forall \ g \in G$ and $d_{gvt} = d_{gvt-1}$ for $v \in I_g \ \forall \ g \in G$, then the exact *aggregate* import price index for (1) is

$$(11) \qquad E^M(\mathbf{P}_t, \mathbf{P}_{t-1}, \mathbf{X}_t, \mathbf{X}_{t-1}, I) = \frac{c_t^M(I_t, \mathbf{d})}{c_{t-1}^M(I_{t-1}, \mathbf{d})}) = IPI(I) \prod_{g \in G} \left(\frac{\lambda_{gt}}{\lambda_{gt-1}} \right)^{\omega_{gt}/(\sigma_g - 1)}$$

where $IPI(I) = \prod_{g \in G} P_g(I_g)^{\omega_{gt}}$ and ω_{gt} are the log-change ideal weights. Equation (11) states that the *aggregate* exact price index is the product of the *aggregate* conventional import price index (*IPI*) and the *aggregate* variety adjusted term. The overall price index *E* is then given by

$$(12) \qquad E = \left(\frac{p_t^D}{p_{t-1}^D} \right)^{\omega_t^D} (E^M)^{\omega_t^M}$$

where the exponents are again the log-change ideal weights.

As stated in Broda and Weinstein (2006), the aggregate import price index in (11) offers three main improvements over prior work. First, this index allows for changes in quality or taste. Equation (11) shows that replacing the ratio of lambdas, $\lambda_{gt}/\lambda_{gt-1}$, with the ratio of the number of varieties in each period, V_{gt-1}/V_{gt}, could yield substantial bias. Second, the new index allows for heterogeneous import goods with different elasticities of substitution, σ_g. Thus, it eliminates the "symmetry bias" arising from the assumption of interchangeable goods. Third, this index remains unchanged even if there is creation or destruction of goods *g*.

3b. Estimating the Elasticity of Substitution

As seen in Equation (11), the first and most important step for estimating the impact of new imported varieties on the price index is to obtain estimates of the elasticity of substitution between varieties of each good. Our empirical strategy again closely adheres to the approach in Broda and Weinstein (2006). There, they claim that the estimation procedure allows for random changes in the taste parameters for imported varieties (where imports of good *g* from a particular country are counted as a variety) and is robust to measurement error in goods' unit values.[4]

The demand for each of the varieties of good *g* is derived from the utility function (2). Demand is expressed in terms of expenditure shares rather than quantities to avoid the potential measurement error imparted from the use of unit values. The import demand equation is given by the following expression:

$$(13) \qquad \Delta \ln s_{gvt} = \varphi_{gt} - (\sigma_g - 1)\Delta \ln p_{gvt} + \varepsilon_{gvt}$$

where $\varphi_{gt} = (\sigma_g - 1)\ln[\phi^M_{gt}(d_t)/\phi^M_{gt-1}(d_{t-1})]$ acts as a random effect since d_t itself is a random variable and $\varepsilon_{gvt} = \Delta \ln d_{gvt}$. The export supply equation is given by the following expression:

4 Prices of particular varieties are not available in general and have to be approximated by unit values.

$$(14) \qquad \Delta \ln p_{gvt} = \psi_{gt} + \frac{\omega_g}{1+\omega_g} \Delta \ln s_{gvt} + \delta_{gvt}$$

where $\varphi_{gt} = -\omega_g \Delta \ln E_{gt} / (1+\omega_g)$; $\omega_g \geq 0$ is the inverse supply elasticity (assumed to be the same across countries) and $\delta_{gvt} = \Delta \ln \nu_{gvt} / (1+\omega_g)$ captures any random changes in the technology factor ν_{gvt}. Since $\omega_g > 0$ in most cases, the export supply curve in general is upward sloping. For the sake of identification, it is assumed that $E(\varepsilon_{gvt}\delta_{gvt}) = 0$. That is, demand and supply errors are uncorrelated once good- and time-specific effects are controlled for.

As in Feenstra (1994) and Broda and Weinstein (2006), we first choose a base country *b* and take the difference of the demand and supply functions between any exporting country and the base country. Then we can eliminate φ_{gt} and ψ_{gt} and make use of the assumption of uncorrelated error terms in supply and demand. Thus,

$$(15) \qquad \Delta^b \ln s_{gvt} = -(\sigma_g - 1)\Delta^b \ln p_{gvt} + \varepsilon^b_{gvt}$$

$$(16) \qquad \Delta^b \ln p_{gvt} = \frac{\omega_g}{1+\omega_g} \Delta^b \ln s_{gvt} + \delta^b_{gvt}$$

where $\Delta^b x_{gvt} = \Delta x_{gvt} - \Delta x_{gbt}, \varepsilon^b_{gvt} = \varepsilon_{gvt} - \varepsilon_{gbt}$ and $\delta^b_{gvt} = \delta_{gvt} - \delta_{gbt}$. Multiplying (15) and (16), noting that $E(\varepsilon^b_{gvt}\delta^b_{gvt}) = 0$, one obtains

$$(17) \qquad (\Delta^b \ln p_{gvt})^2 = \theta_1 (\Delta^b \ln s_{gvt})^2 + \theta_2 (\Delta^b \ln p_{gvt} \Delta^b \ln s_{gvt}) + u_{gvt}$$

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 $u_{gvt} = \varepsilon^b_{gvt}\delta^b_{gvt}$.

The fact that u_{gct} is endogenous makes OLS estimates of $\beta_g = \begin{pmatrix} \sigma_g \\ \omega_g \end{pmatrix}$ inconsistent. However, it is possible to obtain consistency by exploiting the panel nature of the data set and assuming constant supply and demand elasticities for the same good over time. Particularly, GMM is used to exploit the independence of the unobserved demand and supply disturbances for each country over time. According to Feenstra (1994), we can define a set of moment conditions such that

$$(18) \qquad G(\mathrm{b}_g) = E_t(u_{gvt}(\mathrm{b}_g)) = 0 \ \forall \ v$$

as long as all countries exporting good *g* satisfy the following condition:

$$\mathrm{c}^2_{\mathrm{e}^b_{gv}} / \mathrm{c}^2_{\mathrm{e}^b_{gv}} \neq \mathrm{c}^2_{\mathrm{d}^b_{gv}} / \mathrm{c}^2_{\mathrm{d}^b_{gv}}$$

where c^2_x is the variance of *x*. Equation (18), thus, gives us V_g independent moment conditions for each good *g* to estimate the two parameters of interest.

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

$$(19) \qquad \hat{\mathrm{b}}_g = \arg\min_{\mathrm{b} \in B} G^*(\mathrm{b}_g)' W G^*(\mathrm{b}_g)$$

where $G^*(\mathrm{b}_g)$ is the sample analog of $G(\mathrm{b})$; *W* is a positive definite weighting matrix; and *B* is the set of economically feasible b such that $\mathrm{s}_g > 1 \text{ and } \mathrm{w}_g > 0$. As in Feenstra (1994), q_1 and q_2 are first estimated and then used to solve for b_g. The standard errors for b_g are derived using the delta method. In the case that estimates are not well-defined, a grid search of b's over the space defined by *B* is used. In particular, the minimized GMM objective function is computed over $\mathrm{s}_g \in$ [1.05, 131.5] at intervals which are 5 percent apart. Standard errors of b_g in this case are obtained by bootstrapping the grid-searched parameters.

Finally, to simultaneously estimate q_1 and q_2 (which are needed to estimate s_g and w_g) along with a constant, we need data from at least three countries in order to identify b.

4. Results

Following the empirical strategy outlined above, we proceed in three steps in order to estimate the impact of import varieties on Canadian welfare during the period from 1988 to 2007. In the first step, we estimate the elasticity of substitution (among the varieties), s_g, for tens of thousands HS 10-digit goods. Next, we calculate the change in variety, l_g, for each good *g.* After obtaining s_g and the corresponding l_g, we can determine how much the change in variety affects the exact price index for each good *g.* In the final step, we apply our log ideal weights to the change in price due to change in variety for each good *g* and aggregate them to estimate the total variety impact on the general price index of Canadian imports. Once the aggregate impact is obtained, we can easily calculate the variety effect on welfare based on (12). Finally, we decompose the aggregate variety effect into individual country contributions.

4a. Elasticities of Substitution

To estimate (17), we need at least four varieties over at least two years for each HS-10 good. However, the service industry, which corresponds to the HS-2 categories 98 and 99,[5] does not have sufficient observations in each of its HS-10 goods and, thus, no sigmas can be estimated for this industry.[6]

5 These numbers represent the first two digits of an HS code.

6 The mean sigma of this industry, however, is approximated by the mean sigma for the "Miscellaneous imports" category corresponding to HS 90-97 goods.

Table 4: Average Sigmas for HS 2 Aggregation Levels

HS-2 Code*	Industry	Average import share (%)	Number of HS-10 goods per industry	Median number of varieties per HS-10 good	Average sigma**	Standard error**
(1)	(2)	(3)	(4)	(5)	(6)	(7)
01-05	Animal & Animal Products	1.36	603	9.16	4.19	0.83
06-15	Vegetable Products	2.61	884	13.93	3.34	0.50
16-24	Foodstuffs	2.44	674	13.81	3.86	0.63
25-27	Mineral Products	0.12	24	23.83	3.56	0.34
28-38	Chemicals & Allied Industries	7.91	1722	13.85	3.66	0.36
39-40	Plastics / Rubbers,	6.33	787	17.45	2.07	0.46
41-43	Raw Hides, Skins, Leather, Furs	0.54	305	14.36	3.82	0.60
44-49	Wood & Wood Products	3.72	566	19.55	2.36	0.12
50-63	Textiles	3.25	2875	15.92	2.80	0.84
64-67	Footwear / Headgear	0.64	300	15.32	3.88	1.51
68-71	Stone / Glass	2.42	491	14.95	2.81	0.58
72-83	Metals	6.18	2160	13.07	3.41	0.75
84-85	Machinery / Electrical	30.17	3639	14.85	2.09	0.06
86-89	Transportation	22.93	387	12.96	2.35	0.06
90-97	Miscellaneous	7.01	680	24.05	1.64	0.12

(*) HS-2 codes of 98 and 99 refer to the service industry, which accounts for 2.36% of Canadian imports. However, no sigmas can be estimated for this industry due to insufficient observations on its goods at the HS-10 level.

(**) Estimates of the mean sigmas and standard errors are adjusted for parameter censoring.

We estimate the sigmas for 16,097 HS-10 import goods. By comparison, Broda and Weinstein (2006) are able to estimate 13,972 sigmas based on HTS-10 goods for the United States between 1990 and 2001. Clearly, it is impractical to report these sigmas individually. Instead, in Table 4 we report the average estimated sigma for fifteen HS-2 categories—again, with the exception of the service industry, which is excluded.

In column (3) of Table 4, we find that that the most important imports are in “Machinery/Electrical” and “Transportation,” accounting for 30.17% and 22.93% of total Canadian imports, respectively. Column (4) reports the number of HS-10 goods in each industry for which we have estimated sigmas. As might be expected, the highest number of differentiated goods comes from “Machinery/Electrical” and “Textiles,” representing 3,639 and 2,875 estimated sigmas respectively. Column (5) reports the median number of varieties per each HS-10 good. These range from 9.16 for “Animal & Animal Products” to 24.05 for “Miscellaneous” while the overall mean for all imports is 15.80. In Broda and Weinstein (2006), the median number of varieties per HS-10 goods across industries is 18.00. Provided that the mean and median varieties per good in Broda and Weinstein (2006) are roughly the same, our Canadian sample seems to mirror that of the United States. Of course, larger markets like the United States should support more varieties per good than a country like Canada. On the other hand, we have essentially bolstered the number of varieties per good in Canada by treating the US states as separate exporting areas.

As sigma is the elasticity of substitution between varieties, a lower value implies less substitutability, and thus, less price-sensitive demand as suggested in (13). Furthermore, sigma also enters the exact price index (11) in the exponential term. Thus, a smaller value for sigma results in a larger effect for change in variety on the exact price index. The weighted average sigmas of HS-2 categories are reported in column (6). These weighted averages range from 1.64 for “Miscellaneous” to 4.19 for “Animal and Animal Products.”

Almost instinctively, one would expect that the level of substitutability is high in agricultural and mineral products, followed by light manufacturing goods, whereas it is usually low in heavy manufacturing and electrical products. In other words, varieties are expected to be more differentiated in the heavy manufacturing and electrical industry than those in the light manufacturing industry, mining, and agriculture. The average sigmas in column (6) are clearly consistent with these priors. The highest mean sigmas are in agriculture (HS-2: 01-24), followed by mining (HS-2:25-27), light manufacture (HS-2: 28-67), and finally the heavy manufacturing and electrical industries (HS-2: 68-89). The “Miscellaneous” category has the lowest sigmas overall, a perhaps unsurprising result as these imports are, by nature of the categorization, highly differentiated.

By way of comparison, Broda, Greenfield, and Weinstein (2006) estimate the sigmas for the imports of 73 countries including the United States and Canada based on HS-6 goods for the period from 1994 to 2003.[7] Based on a similar estimation method, they report that the median import elasticity of Canada is 5.0 while the simple average is about 10.0, somewhat larger than our estimates. However, they also concede that the average Canadian sigma is not only much higher than those of the United States at 4.20 but also higher than those which they estimate for the entire world at 6.80. Taking their results at face value, one might conclude that Canadian consumers value varieties much less than other consumers worldwide and particularly those in the United States, which is paradoxical, given the strong evidence that Canadian consumers’ tastes are fairly close to those of the United States (Dinnie 2004). Another comparison is with Kee, Nicita, and Olarreaga (2008). They employ HS-6 data for the period from 1988 to 2001, use a rather different estimating strategy, and report that the simple average of Canadian import elasticities is 5.75 while the weighted average is only 1.28. That is, our weighted average

7 A detailed report of the sigmas by country including Canada can be found at http://faculty.chicagobooth.edu/christian.broda/website/research/unrestricted/TradeElasticities/TradeElasticities.html

for sigma falls between their weighted and simple average. Though in this context it is hard to argue which estimation procedure is more precise, our estimates are at least in line with the work of others.

4b. Variety Growth

After obtaining the sigmas, the second step is to calculate the change in variety for each good, I_g. In this case, the calculation of the lambdas requires the existence of common varieties in both 1988 and 2007, i.e., $I_t \neq \emptyset, \text{ t=1988, 2007}$. As seen in Table 1, the dramatic change in goods and varieties means that we are in a position to calculate a much smaller number of lambda ratios than sigmas. Similar to Broda and Weinstein (2006), we assume that whenever a new variety is introduced within a HS-10 category with $I_g = \emptyset$ (i.e., there exist no common varieties), then the other HS-10 entries within the same HS-8 category share a common sigma. In other words, the elasticity of a new variety is a weighted average of the elasticity of other goods and varieties within the same HS-8 category. Similarly, if a new good is introduced within a HS-8 category, then it shares a common elasticity with the other HS-8 goods in the same HS-6 category. Likewise, the same rule applies to new goods introduced with HS-6 and HS-4 categories. However, we note that there are no common varieties in the service industry (HS-2 code: 98-99). In this case, we use the sigmas from "Miscellaneous" (HS-2 code: 90-97) for these two categories.

On this basis, Table 5 reports descriptive statistics for the 623 lambdas we are able to calculate. This number of 623, of course, represents the number of import goods we eventually use to calculate the exact price index. Of the 623 different HS level categories, 52 are aggregated to the HS-2 level, 100 to the HS-4 level, 67 to the HS-6 level, and 56 to the HS-8 level; 348 lambdas remain at the HS-10 level. Although the difference between the number of sigmas and lambdas we estimate is large, we emphasize that this study is still based on highly disaggregated data as the weighted sigmas for the final 623 import goods we use are obtained from the 16,097 individual sigmas. By way of comparison, Broda and Weinstein (2006) generate 926 lambdas from 12,347 sigmas for the period from 1990 to 2001. Their larger number of lambdas is principally due to the shorter time span under consideration, and thus, the higher probability of 1990 goods surviving into 2001.

Table 5: Descriptive Statistics on Lambdas

Variable	Statistic	HS-2	HS-4	HS-6	HS-8	HS-10
Lambda in 1988	5th percentile	0.19	0.04	0.02	0.02	1.00
	Mean	0.53	0.56	0.67	0.50	1.00
	95th percentile	0.94	1.00	1.00	0.99	1.00
Lambda in 2007	5th percentile	0.10	0.02	0.00	0.01	1.00
	Mean	0.46	0.55	0.55	0.46	1.00
	95th percentile	0.99	1.00	1.00	1.00	1.00
Lambda Ratio (l_{07}/l_{88})	5th percentile	0.38	0.19	0.00	0.10	1.00
	Mean	0.91	1.32	0.96	2.75	1.00
	95th percentile	1.44	3.45	1.86	6.84	1.00
Log-Ideal Weight (%)		86.00	8.69	1.78	1.24	2.29
Number of observations		52	100	67	56	348

See text for definitions.

Interestingly, the lambdas for the 348 HS-10 goods equal 1 in both 1988 and 2007. This implies that most of the new varieties at the HS-10 level are created in new goods categories rather than existing ones. This is consistent with a world in which firms distinguish their products from those of their competitors, and as such, monopolistic competition is the prevalent market structure. Though all the 348 HS-10 goods exhibit no change in variety (i.e., the lambdas equal one), they impart very little influence on the overall variety change for the exact price index as their log-ideal weight is only 2.29%. It is the HS-2 level industries which carry the most weight at 86.00%, and their average lambda ratio (λ_{07}/ λ_{88}) is 0.91, implying an increase in variety of 10% (the inverse of the ratio). Similarly, an increase in variety is also documented for the HS-6 level industries. The HS-4 and HS-8 level industries, however, actually report a decrease in variety as their lambda ratios are above unity, but they account for less than 10% of our observations. Thus, we can safely conclude that overall variety did indeed increase in Canada from 1988 to 2007.

In section 3, we noted that the ratio of lambdas is actually a measure of the change in variety weighted by the corresponding import revenue of each variety. This ratio is equal to the ratio of simple count number of varieties V_{1988}/V_{2007} only if the revenue of each variety is identical. From Table 1, we can determine that this ratio is only 0.57, a figure much lower than even the smallest lambda ratio of 0.91 that we estimate for HS-2 industries. In other words, the weighted growth in variety suggested by the simple count data is 75% (=1/0.57-1), a figure much higher than our more carefully weighted growth in variety of 9.9% (=1/0.91-1). This discrepancy is explained by the fact that import shares are very heterogeneous, with existing goods in particular having much higher market shares than new ones. This pattern is also seen in the data for the United States reported in Broda and Weinstein (2006). There, the growth in variety from 1990 to 2001 suggested by count data is more than 117% while the growth in variety from 1990 to 2001 when weighting by import revenue is only 5%.

4c. Import Prices and Welfare

The final step is to combine the estimates of import goods' lambda ratios, their corresponding weights, and elasticities of substitution, in order to calculate the effect of a good's change in variety on the exact price index of imports. According to (11), the aggregate effect of changes in variety on the exact price index of imports can be derived from the multiplication of the individual effects. However, as Broda and Weinstein (2006) and Broda, Greenfield, and Weinstein (2006) argue, it is unlikely that the entirety of the estimated variety effects are reasonable, seeing as how they are derived from tens of thousands individual estimates. The concern is that a single outlier will severely bias the final result through multiplication. Therefore, it is imperative that we exclude outliers before calculating the aggregate effect of changes in variety on the exact price index. We are able to identify 3 clear outliers out of the 623 individual effects: they are all below 0.80 or above 1.10 in value whereas fully 98% of the effects are densely distributed in the range of (0.82, 1.07). The three affected HS industries are fruit wine (2204), film and sheet (3920), and sweet and chilled vegetables (070990). Not surprisingly, the total import share of these 3 outliers is marginal at less than 1.44%.

Excluding these outliers, the aggregate effect of changes in variety on the exact price index of imports between 1988 and 2007 is about 0.35. That is, when adjusted for changes in variety, the exact price index of imports fell 65% faster than the unadjusted price during the period from 1988 to 2007. This represents very rapid annual declines of roughly 5%. Lacking any benchmark for the case of Canada, we again have to compare our results with those reported in Broda and Weinstein (2006) who find that the variety-induced decline in US import prices for the period from 1972 to 2001 was 28% cumulatively, or about 1.2% annually. In the United States, common goods across periods were much more prevalent: from 1972 to 1989, 73% of all varieties survived; from 1990 to 2002, 67% survived. In contrast, this figure is a mere 25% for Canada from 1988 to 2007. In other words, Canada experienced a much more dramatic change in varieties than the United States, and consequently, a larger impact of changes in variety on the Canadian import price index.

The log ideal weight of imports in Canadian GDP, w^M, for the period from 1988 to 2007 is 23.91%. Therefore, the effect of changes in import variety on the general exact price index, Π, is 0.78, or about 1.25% annually. By definition, the exact price index is derived as the minimum cost of a unit of welfare. Therefore, if the general exact price index falls by x%, this is equivalent to welfare increasing by $\frac{x}{1-x}$. Since the growth in import varieties results in the Canadian general exact price dropping by 22% (=1.00-0.78), we can conclude that the welfare gain is about 28% from 1988 to 2007, or about 1.3% annually. Alternatively, one can also interpret the gain via compensation variation: to restore the initial expenditure, a representative consumer is willing to sacrifice x% of her real income should there be an x% drop in the exact general price index. Thus, our results suggest that a representative Canadian consumer would be willing to give up 22% of her real income from 1988 to 2007 in order to gain access to new imported varieties.

Of course, we need to emphasize that all of these results are based on a Dixit-Stiglitz CES utility structure as in (1), (2), and (3), and this utility structure suffers from a few faults. First, it assumes that the elasticities of substitution are time-invariant. Second, the functional form requires that all marginal costs are fixed. Third, there is no interaction between domestic goods/varieties and imported ones. As Arkolakis et al. (2008) argue, an increase in import variety may come at the cost of a reduction in domestic variety. Delineating this interaction remains an important task for future research. Instead, the results we offer here should be regarded as an initial benchmark rather than the final word on the subject; we encourage others to take up where we have left off.

4d. Individual Countries' Contribution to Canada's Welfare Gain

While Table 3 does detail individual exporting area's contribution to the growth in variety of Canadian imports, the ranking is based on pure count data. A more sensible measure in light of the discussion above would be the growth in variety appropriately weighted by the corresponding import revenue. Additionally, with data on hand on the elasticities of substitution and ideal log weights, we can calculate an individual exporting area's contribution to Canadian welfare over this period.

To begin, we note that the most accurate calculation of an exporting area's contribution should be derived from the comparison of the exact price changes, both including and excluding the area of interest as an individual exporting area's activity may affect the estimates of lambdas, omegas, and sigmas. However, such an exercise is computationally cumbersome. Instead, we assume that all estimates of omega and sigma remain the same and consider how much the lambdas are affected when an individual exporting area's change in variety is taken into account. For example, suppose that an exporting area's revenue from new varieties of a good *g* in 2007 accounts for x% of *g*'s total revenue and that the value of disappearing varieties of a good *g* in 1988 accounts for y%. Since the (inverse) weighted growth in variety from 1988 to 2007 is expressed as $\lambda_g^{07}/\lambda_g^{88}$, this particular exporting area's change in variety will affect the aggregate growth in variety by $\left[\lambda_g^{07}\bullet(1-x\%)\right]/\left[\lambda_g^{88}\bullet(1-y\%)\right]$, ceteris paribus. That is, the exporting area's contribution to the growth in variety is given by $(1-x\%)/(1-y\%)$. Therefore, an exporting area can contribute to the aggregate growth in variety via two channels: one way is to contribute a higher new variety revenue share in 2007, i.e., a higher x; another way is to affect a higher rate of survival of its 1988 varieties in 2007, i.e., a lower y.

Table 6 ranks 30 countries and US states by their respective weighted variety growth and contributions to Canadian welfare gain. Not surprisingly, China retains first place when we consider revenue-weighted variety growth, i.e., by the inverse of $(1-x\%)/(1-y\%)$. Its weighted variety growth from 1988

Table 6: Individual Country's Contribution to Canadian Welfare via Variety Growth, 1988 to 2007

Ranking	Country	Weighted Variety Growth (%)	Contribution to Welfare (%)
1	China	84.27	15.74
2	US-Kansas	43.56	9.03
3	US-Colorado	27.20	5.92
4	Thailand	26.05	5.69
5	New Zealand	23.61	5.20
6	France	21.84	4.84
7	Italy	18.30	4.10
8	US-Michigan	16.61	3.74
9	India	14.86	3.37
10	US-South Dakota	12.51	2.86
11	Vietnam	12.05	2.76
12	Mexico	11.02	2.53
13	Uruguay	9.97	2.30
14	Chile	8.57	1.99
15	US-Georgia	8.01	1.86
16	US-Washington (state)	7.62	1.77
17	US-Nebraska	7.07	1.65
18	Russian Federation	6.92	1.61
19	Egypt	6.53	1.52
20	Germany	4.63	1.09
21	US-Missouri	4.24	1.00
22	US-California	4.14	0.97
23	US-Kentucky	3.95	0.93
24	US-Indiana	3.82	0.90
25	Argentina	3.13	0.74
26	US-Texas	2.76	0.65
27	US-North Carolina	2.73	0.65
28	US-Iowa	2.70	0.64
29	US-Illinois	2.29	0.54
30	US-Ohio	2.07	0.49

to 2007 is more than 84%. Other emerging markets, such as Thailand (fourth), India (eighth), and Mexico (twelfth) also experienced rapid variety growth in the Canadian import market. At the same time, historically prominent Canadian trading partners still play an important role. France (sixth), Italy (seventh), and Germany (twentieth) all made the list while fully 16 of the top 30 are US states.

Such growth in variety is also of great benefit to Canadian consumers. For example, the greater range of varieties imported from China alone in this period has improved Canadian welfare by almost 16%. Cumulatively, other Asian countries contributed another 12% while European countries contributed 10%. Considering US states in combination with one another, we find that they contributed almost 34%, underlining the fact that the United States is still the most important force in bolstering Canadian welfare via the growth in import varieties.

For those countries not listed in Table 6, only 42 make a positive contribution to Canadian welfare. The remaining 234 countries have negative impacts on Canadian welfare via the disappearance of varieties, although these effects are quite small in magnitude. Of the 234 countries in question, 199 have an absolute impact on welfare of less than 1%. This, of course, implies that the gains in Canadian welfare via the growth in import variety are attributable to a small fraction of countries with most countries barely maintaining their 1988 level of variety into 2007.

Finally, it is worth noting that the ranking in Table 6 is also noticeable for its absences. In particular, we have in mind other historically prominent Canadian trading partners such as Japan and the United Kingdom, which do not make it into the top 30. We emphasize that the contributions to welfare we have in mind are solely through the growth of variety. So, unlike much of the earlier literature, this welfare gain does not spring from the import of capital or other knowledge intensive goods, making the contribution of Japanese imports, for instance, seem less important than they may really be. Additionally, many of Canada's historically prominent trading partners such as the United Kingdom were already exporting large numbers of varieties in 1988, making the attainment of a high growth rate in variety difficult to sustain, especially in the face of fierce competition from emerging markets.

5. On the Sources of Variety Growth

In explaining the dramatic growth in import variety into the United States, Broda and Weinstein (2006) note that the most plausible explanations for this rise involve some story of the globalization process coupled with an assumption that goods are differentiated by country . . . For example, reductions of trade costs may have made it cheaper to source new varieties from different countries. Alternatively, the growth of economies like China, Korea, and India has meant that they now produce more varieties that the United States would like to import. (p. 553)

In what follows, we present some of the first empirical results relating variety growth to economic growth and the reduction of trade costs. In particular, we draw from a long-standing literature linking immigration with enhanced international trade flows via the reduction of trade costs.

Generally, this link is thought to arise from a few sources: immigrants may have a greater preference for home-country products; immigrants may be in possession of better information regarding arbitrage opportunities between the host and home countries, product differentiation, the regulatory environment of their home countries, and/or the existence of immigrant-specific preferences; or immigrants may be able to better negotiate ethnic networks with respect to issues of culture, trust, and, presumably, language. Gould (1994), one of the first studies of this topic, finds that immigration stocks in the United States via their effects on the transmission of local-market conditions were systematically linked to not only higher levels of imports but also significantly higher levels of exports at the bilateral level. The analysis was extended to highlight the role of consumer manufactured goods in driving much of this result. Using highly detailed state-level trade data, Dunlevy (2006) confirms this result but differentiates countries according to their degrees of corruption and the prevalence of the United States' two dominant languages, that is, English and Spanish. In this case, the pro-trade effect of immigrants is markedly higher for those coming from countries with higher levels of corruption and with official languages other than English and Spanish. Likewise, Bandyopadhyay, Coughlin, and Wall (2008) exploit the same state-level data to document the importance of ethnic networks in driving the link between immigration and trade flows. Given the panel nature of their data, they are also able to identify heterogenous effects across ethnicities, and thus, immigrant populations.

In the Canadian context, Head and Ries (1998) were apparently the first to bring this question north of the border. Here, they identify much stronger results for immigrants on Canadian imports than exports, differential effects on Canadian trade according to immigrant class with those immigrating under the entrepreneur class commanding a surprisingly weak performance, and differential effects on Canadian trade according to region of origin with those immigrating from East Asia expanding trade more than immigrants from any other region. Coming on the heels of this study and anticipating the broader move to considering sub-national trade accounts, Wagner, Head, and Ries

(2002) consider more exacting specifications of the underlying gravity model, finding results which simultaneously support but temper those of previous studies.

At the same time, most of this literature has concerned itself with the effects of immigration only on bilateral trade flows, whether this be at the national or sub-national level (Hatzigeorgiou 2010). One notable and recent exception is the work of Peri and Requena (2009). In this paper, they document the very pronounced rise in Spanish immigration over the period from 1995 to 2008. What is more, they exploit highly detailed transaction-level trade data for Spanish provinces and are able to decompose the effects of immigration on Spanish exports along two margins. The extensive margin measures the increase in the number of exporting firms while the intensive margin measures the increase in the volume of exports of existing firms. They not only find a significant effect of immigration on Spanish exports but also are able to attribute the bulk of export growth to the extensive margin.

Here, we extend this literature by considering not the effects of immigration on the volume of trade but rather the effects of immigration on the variety of imports. Our running hypothesis is that immigration can positively contribute to variety growth. This relationship comes about via immigration's reduction of trade costs in the form of the informational barriers to trade. At the same time, we heed Broda and Weinstein's suggestion that economic growth may also be partially responsible for the growth in import varieties. Thus, our baseline regression takes the following form,

$$(20) \qquad \ln(V_{jt}) = \phi_j + \theta_t + \alpha \ln(IMM_{jt}) + \beta \ln(Y_{ct}Y_{jt}) + \varepsilon_{jt},$$

where V_{jt} is the number of varieties from country j in time t, $\square_j$ represents a set of exporting country fixed effects, θ_t represents a set of time fixed effects, IMM_{jt} is the stock of immigrants to Canada from country j in time t, and $Y_{ct}\,Y_{jt}$ is the product of Canada's and country j's gross domestic product in time t. The figures for gross domestic product were derived from the Penn World Tables version 6.3 while immigrant stocks were derived from the *Canadian Census of Population* for 1996, 2001, and 2006.[8]

TABLE 7: SUMMARY STATISTICS

VARIABLE	OBS.	MEAN	ST. DEV.	MIN.	MAX.
Varieties (logged)	152	7.04	1.86	0.00	12.59
Immigrants (logged)	152	10.97	0.94	9.65	13.39
Product of GDPs (logged)	152	39.50	1.85	34.48	44.08

TABLE 8: REGRESSION RESULTS

Dependent variable in all regressions: Varieties (logged)

	(1)			(2)		
	COEFFICIENT	STD ERROR	P-VALUE	COEFFICIENT	STD ERROR	P-VALUE
Immigration (logged)	0.4203	0.2163	0.06	0.2053	0.0877	0.02
Product of GDPs (logged)	0.6250	0.3975	0.12	0.1243	0.0244	0.00
Observations		152			152	
R-squared		0.9480			0.9294	

Notes: Time and country fixed effects suppressed in column (1). Robust standard errors reported.

Table 7 reports the summary statistics for our three variables of interest while column (1) of Table 8 gives the results from estimating equation (20). The point estimates are of the expected sign, although that for joint outputs is insignificant at the 10% level. The point estimate for immigrant stocks is, however, statistically significant with a 1% increase in immigrants stocks being associated with a 0.42% increase in the number of varieties. The specification in column (2) tries to account for any spurious correlation which may arise if

8 Unfortunately, previous versions of the census, in particular those of 1991 and 1986, do not report immigrant stocks in a sufficiently disaggregated manner to match the span of our dataset on import varieties from 1988 to 2007.

the variables of interest are trending in the same direction over time. Here, estimation takes place by means of seemingly-unrelated-regression (SUR) where observations on import varieties, immigrant stocks, and joint output in a given time period are treated as a single equation. The coefficients on immigrant stocks and joint output are restricted to be equal across equations. Although the coefficients register as being somewhat smaller than before, they still suggest a powerful role for immigrants on import variety with an estimated elasticity of 0.21.

In combination, what these results suggest is that, on balance, a 1% increase in immigration would lead to an increase in import varieties of about 0.3%. Table 1 above documented the fact that the growth of Canadian import varieties ran at 3.03% per year from 1988 to 2007. At the same time, the stock of immigrants to Canada rose by 2.39% per year. Pushing our results very hard, this would imply that immigrants to Canada are responsible for as much as 24% (=2.39*.003/.0303) of the growth in Canadian import varieties in any given year. These results are significant in a few respects. First, we earlier suggested that the aggregate growth in import varieties over the period from 1988 to 2007 may have increased Canadian welfare by as much as 28%. Taken at face value, our results would imply that the average Canadian consumer was roughly 7% better off in 2007 than in 1988 simply due to the enhanced varieties of import goods associated with immigration. Finally, these results are an important contribution to an emerging literature on the effects of immigration on host countries which moves beyond standard considerations of competition (or complementarity) in local labor markets. Thus, future debates on further immigration must consider the costs and benefits to host countries not solely in terms of immigrations' impact on wages and incomes but also in terms of immigrations' impact on consumer welfare via the type of variety effects documented here as well as the effects of immigration on the prices of other traded and non-traded goods (cf. Cortes 2008; Lach 2007).

6. Conclusion

In this paper, we have considered the issue of import variety growth, its implications for the broader economy, and some of its potential sources. In the case of Canada, we document that import varieties grew 76%, that this growth is associated with a welfare gain as large as 28%, and that enhanced immigration flows may be responsible for 25% of this variety growth and its attendant welfare gains.

One of the keys to these results has been the use of highly disaggregated Canadian trade data, especially with respect to the United States. Since Canadian agencies have consistently recorded import data not only on a very wide range of commodities but also at the level of US states, we have been able to employ a new working definition of variety which moves beyond the traditional taxonomy of a particular good from a particular country by considering sub-national accounts. Perhaps not surprisingly, we are able to document higher rates of import variety growth, and hence, larger welfare gains than would potentially be the case by treating the United States as a single entity. We feel that this points one way in advancing the literature in defining varieties more precisely and using data more consistently.

At the same time, our results warrant a few caveats. First, there is a marked need for considering more flexible utility structures than the Dixit-Stiglitz CES framework employed here. In particular, a better handle on issues relating to time-variant elasticities of substitution are needed. On a related note, greater consideration of the competition among varieties—both of domestic and foreign origin—is warranted. The extent to which foreign varieties “crowd out” existing or even potential domestic varieties could have a dramatic effect on any welfare calculations. Finally, more work should be done in unlocking the “black box” surrounding immigration and traded varieties and volumes. After nearly twenty years of research uncovering the link between immigrant populations and international trade, very little is known about the precise mechanisms driving the stimulative effects of immigration on the extensive and intensive margins of international trade. These and the other issues raised by this paper obviously remain for future work.

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