

Lewrick, Ulf; Mohler, Lukas; Weder, Rolf

Working Paper

International Trade in Variety and Domestic Production

WWZ Discussion Paper, No. 2011/03

Provided in Cooperation with:

Center of Business and Economics (WWZ), University of Basel

Suggested Citation: Lewrick, Ulf; Mohler, Lukas; Weder, Rolf (2011) : International Trade in Variety and Domestic Production, WWZ Discussion Paper, No. 2011/03, University of Basel, Center of Business and Economics (WWZ), Basel,
<https://doi.org/10.5451/unibas-ep27959>

This Version is available at:

<https://hdl.handle.net/10419/123414>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

March 2011

International Trade in Variety and Domestic Production

WWZ Discussion Paper 2011/03

Ulf Lewrick, Lukas Mohler, Rolf Weder

The Authors:

Ulf Lewrick, Dr.rer.pol.

Faculty of Business and Economics
International Trade and European Integration
University of Basel
Peter Merian-Weg 6
CH - 4002 Basel
Switzerland
phone: +41(0)61 267 33 03
ulf.lewrick@unibas.ch

Lukas Mohler, MSc.

Faculty of Business and Economics
International Trade and European Integration
University of Basel
Peter Merian-Weg 6
CH - 4002 Basel
Switzerland
phone: +41(0)61 267 07 70
lukas.mohler@unibas.ch

Rolf Weder, Prof. Dr.

Faculty of Business and Economics
International Trade and European Integration
University of Basel
Peter Merian-Weg 6
CH - 4002 Basel
Switzerland
phone: +41(0)61 267 33 55
rolf.weder@unibas.ch

Homepage: <http://wwz.unibas.ch/en/divisions/home/abteilung/aei/>

A publication of the Faculty of Business and Economics, University of Basel.

© WWZ Forum 2011 and the author(s). Reproduction for other purposes than the personal use needs the permission of the author(s).

Contact:

WWZ Forum | Peter Merian-Weg 6 | CH-4002 Basel | forum-wwz@unibas.ch | www.wwz.unibas.ch

International Trade in Variety and Domestic Production[☆]

Ulf Lewrick^{a,1}, Lukas Mohler^{a,*}, Rolf Weder^{a,2}

^a*Faculty of Business and Economics, University of Basel, Peter Merian-Weg 6, CH-4002 Basel, Switzerland*

Abstract

Welfare gains from increasing product variety are an important source of the gains from international trade. Recent empirical studies have largely focused on measuring the gains from an increased variety of imports. Trade theory, however, suggests that international trade heavily affects the variety of domestically produced goods as well. To overcome the typical data limitations on domestic varieties, we employ the number of domestic establishments as a proxy of the number of domestic varieties and include information on business dynamics to assess the importance of new and disappearing varieties. Our results suggest that for U.S. manufacturing, losses in domestic varieties from 1992 to 2006 are substantial and outweigh the gains from increased imported varieties.

Keywords: Variety gains, margins of trade, lambda ratio, U.S. manufacturing
JEL: F10, F12, F14

[☆]We thank Christian Rutzler as well as seminar participants at the 2010 Annual Conference of the European Trade Study Group (ETSG) in Lausanne and the University of Basel for helpful comments. Financial support from the Swiss National Science Foundation (Project No. 100014-124975) is gratefully acknowledged.

*Corresponding author. Tel.: +41 61 267 0770.

Email addresses: ulf.lewrick@unibas.ch (Ulf Lewrick), lukas.mohler@unibas.ch (Lukas Mohler), rolf.weder@unibas.ch (Rolf Weder)

¹Tel.: +41 31 322 6236.

²Tel.: +41 61 267 3355.

1. Introduction

The trade-induced increase in the variety of products and services available in a country is an important source of the gains from trade. Whereas Grubel and Lloyd (1975) were the first to show that intra-industry trade is in fact an increasingly important phenomenon in world trade, the highly influential work by Krugman (1979, 1980) managed to explain the observations made, based on a fundamental type of general equilibrium model that attracted significant theoretical interest.

The empirical literature measuring the gains from variety is, however, quite young. It has been sparked by the seminal work of Feenstra (1994) who established a new approach to estimate these gains. The emphasis so far has been on the gains arising from changes in imported varieties as proposed by Feenstra (1994), relying on now widely available import data. Broda and Weinstein (2006) applied this approach to quantify the gains from variety for the United States. They estimate that these gains amount to a cumulative 2.6% of U.S. GDP from 1972 to 2001. Other studies find gains from variety of a similar magnitude, as, for example, Mohler and Seitz (2010) and Mohler (2011) who calculate the gains from variety for each of the 27 members of the European Union as well as Switzerland. They report variety gains of up to 2.8% for periods of 10 to 17 years.

This paper focuses on the relationship between imported varieties and domestic varieties, i.e. the varieties produced in a country. We argue that the magnitude of the trade-induced reduction of domestic varieties is largely neglected in the empirical literature or, if it is taken into account, considerably underestimated. Trade theory is, of course, aware of the fact that international trade may reduce the number of varieties produced in a country. In a Krugman (1979) type model, this relationship is, in fact, a key prerequisite that economies of scale are exploited, thus inducing prices

to fall.³ To empirically investigate the adjustment in domestic variety, we use the approach developed by Feenstra (1994), taking the number of active establishments in U.S. manufacturing sectors as a proxy for the measurement of domestic varieties.

Our analysis proceeds in two steps. In a first step, using unweighted count data, we show that the gains from an increased variety of imports amount to 5.0% of U.S. GDP from 1992 to 2007. Correcting for the associated decline in domestic varieties cuts these gains to 1.8%. In a second step, we improve our measure of the gains from variety by weighting the varieties according to their relative importance. This procedure is well-established in the literature for imported varieties, but cannot be generally applied to domestic varieties due to data limitations. We thus propose a procedure employing business dynamics statistics to derive the appropriate weights for domestic varieties. Our results suggest that the total gains from variety in U.S. manufacturing turn into a net loss of 1.3% of U.S. GDP from 1992 to 2006, if the loss in domestic varieties is accounted for.

Two factors drive this somewhat surprising result. First, we observe a distinct decline from 5.0% to 1.0% of U.S. GDP in the gains from *imported* varieties as we switch from count data to the weighted estimates. This downward adjustment of 80% is in line with Broda and Weinstein (2006, p. 576) who found a 60% downward correction for the United States for the period from 1972 to 2001. As shown in Arkolakis et al. (2008), the overestimation of the gains from imported varieties stems from the strong heterogeneity in import shares, with new and disappearing varieties typically being less important than those available throughout the observation period.

Second, by weighting new and disappearing establishments by their contribution to employment—our proxy for expenditure—and taking into account the evolution of these establishments over time, the loss from reduced *domestic* variety remains

³Domestic variety is endogenous in most recent models and falls with a decline in trade costs, i.e. Melitz (2003), Eaton et al. (2008), Arkolakis et al. (2008), Baldwin and Forslid (2010) or Feenstra (2010).

substantial, amounting to 2.3% of U.S. GDP. The resulting total welfare loss from a change in varieties remains robust to several alternative specifications. Thus, we conclude that the magnitude of the corrections found in this paper justifies a thorough analysis of the industry dynamics at work in domestic production when the gains from international trade in variety are assessed.

There are other contributions in the literature related to our analysis. Though Broda and Weinstein (2006) do not specifically account for the substitution between imported and domestic varieties, the authors propose a slight reduction of the calculated gains in the U.S. case from the estimated 2.6% to 2.2%, relying on a rough estimate based on Helpman and Krugman (1985, pp. 197-209). This small correction, however, contrasts with our results and may be due to the strong foundation of their model in the constant elasticity of substitution (CES) framework based on Krugman (1980) that is also used by others such as Melitz (2003) in a setting with heterogeneous firms. Bernard et al. (2009) argue, however, that the response in the extensive margin considered in these models only captures a fraction of firms' adjustments. Our approach allows for an adjustment in the intensive margin, which itself has a considerable impact on the number of establishments and thus the number of varieties produced.

Our paper is further related to Ardelean and Lugovskyy (2010) who also emphasize the importance of a change in the number of domestically produced varieties. They, however, take a different route in adjusting the Krugman (1980) specification and allow some substitution between imported and domestic varieties based on different productivity at the firm level. Falling trade costs thus lead to an adjustment in the domestic sectors along the extensive margin. Their results based on count data also imply that the sector-specific gains from trade in variety in U.S. manufacturing can be biased upwards if the change in domestic variety is not taken into account. Their benchmark estimate suggests an average upward bias of 8%, which is considerably less than ours.

The remainder of the paper is organized in four sections. In Section 2, we specify our definition of a variety and present the relevant U.S. manufacturing data. Section 3 highlights the methodology for the empirical analysis. In Section 4, we present the estimation results and check their robustness. In particular, we carefully describe our procedure to determine the different weights for new, common and disappearing domestic varieties. Section 5 concludes.

2. The Definition of a Variety and the U.S. Manufacturing Data

In empirical research, the definition of a variety typically depends on data limitations. In their analysis of the gains from variety in the U.S. automobile sector, Blonigen and Soderbery (2010), for example, define a specific make and model of automobiles as a variety, e.g. Ford Focus and Toyota Corolla as different varieties of compact automobiles. Broda and Weinstein (2010) use an even more disaggregated definition. The authors distinguish varieties based on the product bar code which allows them to cover some 700,000 varieties bought by approximately 55,000 U.S. households. Such data sets offer a very detailed view of varieties in a certain industry. Our interest, however, is to provide a measure of variety for all manufacturing sectors and to relate it to international trade data. We first present our definition and then describe the data.

2.1. Defining Domestic and Imported Varieties

Given our data set, we define the number of domestic varieties to equal the number of active establishments. A change in the number of establishments thus equals a change in the extensive margin. A change in the average quantity of production, calculated as total shipments divided by the number of establishments, is assumed to equal a change in the intensive margin. This definition of a variety fits nicely with the monopolistic competition model used in the international trade literature where each firm or establishment produces exactly one variety. It is considerably broader than the

definition used in the above-mentioned studies. The key advantage of our definition is the comprehensive coverage of all manufacturing sectors. In addition, the necessary data are becoming available for a growing number of countries, which will allow for cross-country comparisons in future work.

In our analysis, sectors are defined in accordance with the North American Industry Classification System (NAICS) for manufacturing industries. The data on domestic production are taken from the U.S. Census Bureau and cover annual production in manufacturing sectors at the NAICS 6-digit level for the period from 1992 to 2007.⁴ Each sector will be assumed to produce one differentiated good (“cookies and crackers” as one example of a sector at the 6-digit level, i.e. NAICS 311821) which is composed of several varieties approximated by the number of establishments in this sector.

As to imported varieties, it has become standard in the literature to proxy them based on the Armington (1969) assumption, differentiating between the goods’ countries of origin. We will follow this route as well. Note, however, that the available level of disaggregation in the import data is more detailed than for domestic production. A good (e.g. “cookies and crackers”) will therefore include several imported products, defined at the Harmonized Tariff Schedule (HTS) with ten digits (e.g. “frozen sweet biscuits containing peanuts”, i.e. HTS 1905.3100.21). Thus, the number of imported varieties within each 6-digit NAICS sector is equal to the number of HTS-10 product-country pairs imported by the U.S. within that sector.

The trade data we use are the same as in Schott (2008) and originate from the U.S. Census as well. We assign the imported varieties to the manufacturing sectors as described in Pierce and Schott (2009) which allows us to cover about 85% of all U.S. imports between 1992 and 2007. With respect to the import data, the extensive margin is defined as the number of imported varieties per sector, whereas the intensive margin

⁴The economic census survey is conducted every five years and includes detailed data on manufacturing sectors for 1992, 1997, 2002, and 2007.

equals the total value of imports per sector divided by the number of imported varieties. At the 6-digit level, the data thus incorporate approximately 230,000 imported varieties in 2007 (up from approximately 160,000 in 1992) against roughly 180,000 varieties produced domestically in 2007 (down from approximately 200,000 in 1992) in about 350 manufacturing sectors.⁵

2.2. Characterization of the U.S. Manufacturing Data

Based on the variety definitions above, Tables 1 and 2 illustrate the relative changes in both margins for imports and domestic production for NAICS-3 sectors, respectively. Production values are in real terms.⁶ According to the first row in Table 1, U.S. manufactured food imports increased by 98.48% in real terms from 1992 to 2007. The number of imported varieties as defined in Section 2.1 rose by 47.63%, whereas average sales per imported variety rose by 34.44%. Turning to Table 2, we observe that during the same time, the number of active U.S. establishments in this sector (i.e. our measure of domestic varieties) fell by 3.27%. These establishments, on average, sold 4.82% more in real terms in 2007 as compared to 1992. This results in a real increase of total domestic sales in the sector by 1.39%.

Insert Tables 1 and 2 approximately here

Two observations stand out. First, we observe a strong adjustment in both margins for both imported and domestic varieties. Models that limit adjustment to either margin will therefore neglect a significant share of the industry dynamics at work. Also, the adjustment in the extensive margin fails to predict both the size and direction of the

⁵The NAICS 6-digit level distinguishes 450 manufacturing sectors. Our estimates include the 358 of these for which domestic production can be matched with manufacturing import data. This allows us to consider about 200,000 of the 330,000 U.S. manufacturing establishments that were active in 1992, for example.

⁶We correct for domestic inflation using sector-specific producer price indices, available from the Bureau of Labor Statistics (BLS). Nominal import values are adjusted by import price indices available at the HTS-2 level from the BLS.

adjustment in the intensive margin. While the impressive overall growth in imports rests on a pronounced rise in both margins, domestic production—at the aggregate level—shows the extensive margin decline and the intensive margin grow. At the sector level of domestic production, we observe every possible combination of the direction of adjustment in the extensive and intensive margin.

Second, there is evidence for a significant relationship between international trade and domestic production. For total U.S. manufacturing, the sign of the observed change in the two margins of domestic production is consistent with a monopolistic competition trade model with an endogenous elasticity of substitution. The differences across sectors, however, are substantial. U.S. production in sectors with relatively large shares of high-skilled workers (e.g. computer and electronic products, transportation equipment) expanded, whereas sectors typically considered having a greater share of low-skilled labor (e.g. apparel, leather products) contracted. As shown by Bernard et al. (2006), this contraction in U.S. production may, in part, be attributed to import competition from labor-abundant, low-wage countries. Recent studies by, for example, Ebenstein et al. (2009) on offshoring activities of U.S. companies to low-wage countries also hint at negative employment effects for manufacturing in the U.S., though of limited size.

Improvements in labor productivity are also frequently referred to as a source of employment decline in (some) U.S. manufacturing sectors, as, for example, shown by Deitz and Orr (2006) or Forbes (2004). To obtain some perspective, note that from 1992 to 2007 total U.S. manufacturing employment declined by about 25%, some 4.8 million jobs. As international trade models show, trade liberalization is one of the driving factors of productivity improvement. Following the heterogeneous firms models, e.g. Melitz (2003) or Bernard et al. (2003), a decline in trade obstacles induces the most productive firms to expand, while less productive firms contract or exit. The selection of firms and the shift in market shares to the most productive ones leads to a rise in

aggregate productivity.

In other words, there are good reasons to assume a direct link between the changes in domestic production and imports observed in Tables 1 and 2. The pronounced difference in the evolution of imports and domestic production shown above thus warrants a thorough analysis of the impact of domestic variety adjustment on the overall gains from variety. In addition, the diverse pattern of the adjustment in the intensive margin across sectors suggests that we cannot simply infer the change in domestic varieties from import data. Our proposed definition of a domestic variety permits us to estimate the variety gains directly from the data.

3. Methodology

This section develops a measure which allows us to estimate the welfare effects arising from a change in variety in imports and domestic production. We rely on the well-established approach developed by Feenstra (1994). The idea is to estimate the effects of a change in varieties on the price index of an economy. We start with the exact price index and then introduce a simplified index that will be used in the first part of our empirical analysis.

3.1. The Exact Price Index and the Total Gains from Variety

We consider the United States as the home country, indexed by h , and the rest of the world as the foreign country, indexed by f . To start, we define the exact price index Π for good s , of which both imported and domestic varieties are supplied in the home country:

$$\Pi_s = P_s \left(\frac{\lambda_{fst}}{\lambda_{fst-1}} \right)^{\frac{\omega_{fs}}{\sigma_s-1}} \left(\frac{\theta_{hst}}{\theta_{hst-1}} \right)^{\frac{\omega_{hs}}{\sigma_s-1}}. \quad (1)$$

Π_s was developed by Feenstra (1994) who introduced the lambda ratio, $(\lambda_{fst}/\lambda_{fst-1})$ and extended by Broda and Weinstein (2006) to encompass the case of multiple aggre-

gate goods. Ardelean and Lugovskyy (2010) introduced the theta ratio, $(\theta_{hst} / \theta_{hst-1})$, to account for changes in the domestically produced variety set. The derivation of this index and its underlying assumptions have been presented in the literature in great detail. We therefore refer the reader to the Appendix for the derivation of the index and limit ourselves in the following to the intuition regarding the relationships established by equation (1).

P_s is the exact price index for a constant variety set in sector s . Due to the assumed consumer preference for variety, a rise (decline) in the number of available varieties, *ceteris paribus*, should yield a gain (loss) in the consumer's real income, and thus reduce (raise) Π_s . This relationship is captured by the lambda ratio for the change in imported varieties and by the theta ratio for the change in domestic varieties. These ratios are weighted by the corresponding log-change weights, ω_{fs} and ω_{hs} , that measure the share of imports and domestic production in total demand, respectively, as well as by the elasticity of substitution between varieties (σ_s) in this sector. The elasticities are assumed to be greater than unity, identical within a sector, but different across sectors.⁷ The ω 's are defined in the Appendix. λ_{fst} and θ_{hst} in equation (1) are calculated as follows:

$$\lambda_{fst} = \frac{\sum_{v \in I_{fs}} e_{fsvt}}{\sum_{v \in I_{fst}} e_{fsvt}} \quad \text{and} \quad \theta_{hst} = \frac{\sum_{u \in I_{hs}} e_{hsut}}{\sum_{u \in I_{hst}} e_{hsut}}, \quad (2)$$

where v and u stand for the different imported and domestic varieties of good s available to the consumer. e represents the consumer's expenditure on these varieties. An example of e_{fsvt} is the dollar amount spent on frozen sweet biscuits containing peanuts imported from France in a given year, whereas the corresponding e_{hsut} equals the dollar amount spent on cookies and crackers produced by a domestic, i.e. U.S., establishment.

⁷If the data permit, one can distinguish between the elasticity of imported σ_{fs} and domestic varieties σ_{hs} . However, due to data restrictions this is often, and also in our case, not possible; one thus has to rely on the simplifying assumption that within sectors imported and domestic varieties are equally substitutable, i.e. $\sigma_{hs} = \sigma_{fs} = \sigma_s$.

Varieties are grouped into different sets depending on their availability over time. Varieties included in the sets I_{fs} and I_{hs} are available to the consumer at both time t and $t - 1$ and are referred to as varieties of the “common sets”. Varieties available to the consumer at time t are included in the sets I_{fst} and I_{hst} and these sets include the varieties of the common set plus the new varieties, not available at time $t - 1$. By analogy, the computation of λ_{fst-1} and θ_{hst-1} in the denominators in equation (1) requires the definition of the two sets I_{fst-1} and I_{hst-1} . These sets include the varieties of the common set as well as disappearing varieties, available at $t - 1$, but no longer at t . $t - 1$ corresponds to the first and t to the last year of the period we intend to analyze.

If consumers spend more on new domestic (imported) varieties, all else being equal, the theta (lambda) ratio decreases, raising the consumer’s real income. This can be equally due to significant expenditures on a few new varieties or to expenditure spread over a large number of new varieties. If by contrast expenditures for disappearing varieties rise, the ratios increase, leading to a decline in real income. The magnitude of these effects also depends on the substitutability of the varieties of each good, as captured by the elasticities of substitution. If varieties are close substitutes, i.e. if σ_s is large, additional varieties contribute little to additional variety gains. Finally, the relative importance of changes in imported and domestic varieties depends on their weights in the price index.

A sector s exhibits gains from variety if its exact price index, Π_s , is smaller than its corresponding price index, P_s , assuming a constant variety set. The sector’s total variety gains, VG_s , are typically expressed as the relative difference of these indices:

$$VG_s = \frac{P_s - \Pi_s}{\Pi_s} = \left[\left(\frac{\lambda_{fst}}{\lambda_{fst-1}} \right)^{\frac{\omega_{fst}}{\sigma_s - 1}} \left(\frac{\theta_{hst}}{\theta_{hst-1}} \right)^{\frac{\omega_{hst}}{\sigma_s - 1}} \right]^{-1} - 1. \quad (3)$$

In addition to the total variety gains, we want to identify how imported and domestic varieties individually contribute to these gains. To do so, we decompose the total

variety gains into the variety gains from imports, VG_{fs} , as well as from domestic production, VG_{hs} :

$$VG_{fs} = \left[\left(\frac{\lambda_{fst}}{\lambda_{fst-1}} \right)^{\frac{\omega_{fst}}{\sigma_s - 1}} \right]^{-1} - 1 \quad \text{and} \quad VG_{hs} = \left[\left(\frac{\theta_{hst}}{\theta_{hst-1}} \right)^{\frac{\omega_{hst}}{\sigma_s - 1}} \right]^{-1} - 1. \quad (4)$$

The variety gains from imports measure the gains that arise if we assume the set of domestic varieties to be constant. In this case, the theta ratio in equation (3) has unit value. This measure corresponds to the gains calculated in Broda and Weinstein (2006). By analogy, the variety gains from domestic production capture the gains that arise if only the domestic variety set alters. In this case, the lambda ratio in (3) is assumed to have unit value.

3.2. Simplification Using Count Data

Calculating the lambda and the theta ratios requires detailed data on the expenditure shares of new and disappearing varieties. Due to the restriction of the data, these calculations are often not feasible. A simplified index used by Ardelean and Lugovskyy (2010) is helpful in cases like this. It is based on the assumption that new, disappearing, and common varieties have equal prices and quantities in a given year. The lambda and theta ratio then become simple count measures, as the expenditures (e) in the different sets of varieties are simply multiplied by the corresponding number of varieties (N) in equation (2). Thus,

$$\frac{\lambda_{fst}}{\lambda_{fst-1}} = \frac{N_{fst-1}}{N_{fst}} \quad \text{and} \quad \frac{\theta_{hst}}{\theta_{hst-1}} = \frac{N_{hst-1}}{N_{hst}}, \quad (5)$$

where N_{fst} (N_{hst}) is the number of varieties of the set I_{fst} (I_{hst}), i.e. the varieties consumed in t , and N_{fst-1} (N_{hst-1}) is the number of varieties of the set I_{fst-1} (I_{hst-1}), i.e. the varieties consumed in $t - 1$.

This simplification serves as a useful and intuitive reference point for assessing the gains from variety. Its drawback, as we will discuss in Section 4.3, is that the estimated gains will be biased if expenditure shares differ systematically across new, disappearing and common varieties. Ardelean and Lugovskyy (2010) rely on this simplification to approximate the gains from domestic varieties by inferring VG_{hs} from changes in imported varieties and using data on the home country's relative productivity per sector and variable trade costs. Thereby, they circumvent the need to specify a domestic variety and are able to estimate the variety gains based on widely available trade data. Their underlying model implies a constant intensive margin per variety which allows the ratio of imported to domestic varieties to be expressed solely in terms of variable trade costs, productivity differences, and elasticities of substitution. Yet, as shown in Tables 1 and 2, the intensive margin changes significantly in nearly all sectors of our data set with no obvious link between imports and domestic production within a sector. Our proposed direct proxy of the number of domestic varieties thus allows adjustments both at the intensive and the extensive margin to be taken into account. This measure of the domestic variety gains can therefore allow for any development that is specific to a domestic sector and that could not be derived from or is not reflected in the trade data.

4. Empirical Analysis

We now apply the methodology presented in Section 3 to estimate the gains from variety for the U.S. manufacturing sectors from 1992 to 2007. First, we estimate the elasticities of substitution for each sector based on the import data. Second, we estimate the total gains from variety and their decomposition based on the simplified price index using count data. This allows us to compare our results with those of other studies. Third, we employ information on U.S. manufacturing firm dynamics to estimate the expenditure share of new and disappearing domestic varieties in Section

4.3. This will allow us to estimate the exact price index in the Section 4.4.

4.1. Estimating Elasticities

The elasticities for each sector are estimated for different levels of aggregation based on the methodology by Feenstra (1994) and Broda and Weinstein (2006) using import data. Summary statistics for the 6-, 4- and 3-digit NAICS level are presented in Table 3.⁸

Insert Table 3 approximately here

As expected, the elasticity estimates are lower for higher levels of aggregation. This indicates that varieties from broader defined sectors are less substitutable. Our estimates are also in line with the elasticities reported in Broda and Weinstein (2006). The fact that they are slightly lower in our estimation—with a median of 2.44 at the 6-digit NAICS level compared to a median of 3.1 at the HTS-10 level in Broda and Weinstein (2006), p. 568—fits with the broader definition of a sector in our investigation.

4.2. Calculating Gains from Variety Using Count Data

We calculate the gains from variety as defined in (4) for imported and domestic varieties, using the simplified lambda and theta ratios from (5) and the estimated elasticities for all manufacturing sectors. Table 4 displays the results at the 3-digit sector level in terms of U.S. GDP in the first two columns.⁹ The last column of Table 4 shows the total gains from variety as defined in (3), also using count data. Table 4, for example, reports that users of chemical products benefited from an increase in total variety within this sector that was equal to a rise in their real income of 10.4% from

⁸Note that for 10 of the 358 6-digit sectors it was not possible to estimate an elasticity due to a too small number of observations. For these 10 sectors, we use the corresponding 3-digit sector estimates in the 6- and 4-digit level estimates in the remainder of the paper.

⁹We compute the gains at the NAICS 6-digit level but, in the interest of brevity, report the results at the NAICS 3-digit level. We use ideal log-change weights to aggregate the sectors from NAICS-6 into NAICS-3. Furthermore, we drop the category “miscellaneous”, because the expected heterogeneity of the varieties included in this category suggest that measures of substitutability may be misleading.

1992 to 2007. Note that this is due to an increase of imported varieties with a welfare effect of +1.72% and an increase of domestically produced varieties with an effect of +8.53%.

Insert Table 4 approximately here

Over all sectors, the results in Table 4 suggest that total gains from variety would largely be overestimated if only the gains from imported varieties were taken into account. While all sectors, with the exception of wood products, experience positive gains from imported varieties, domestic variety losses occur in three-quarters of the sectors. Combining both effects, 12 out of 20 sectors witness total variety losses. Aggregating all sectors, we find that U.S. consumers would be willing to spend 4.95% of their income to gain access to the imported variety set available in 2007 as compared to that in 1992. By contrast, the decline in the number of available domestic varieties corresponds to a fall in real income of 3.03%. The total gains from variety, nevertheless, are positive, estimated at 1.77% of U.S. GDP.

Welfare gains from variety are thus corrected downward by 64%. How does this correction compare to previous estimates in the literature? First, Broda and Weinstein (2006, p. 581) adopt the theoretical assumptions of Helpman and Krugman (1985) and find that their welfare estimate would decrease by 16% if corrected for the associated reduction of domestic varieties. Second, Ardelean and Lugovskyy (2010) quantify this bias by 8% for U.S. manufacturing on average in their benchmark estimate.¹⁰ Our estimation is considerably different from these reports. The corrections in these two studies, however, are indirect in the sense that they are calculated using import data in estimating how imported varieties may have affected domestic varieties relying on predictions of a particular modelling approach. By comparison, our approach employs empirical data on domestic production.

¹⁰Note that they, however, also report a 66% downward correction in one of their alternative specifications.

Nevertheless, the correction is relatively large. We attribute this to several factors. During the sixteen years observed, U.S. manufacturing was both characterized by a significant relocation of production to foreign countries as well as rising import competition. These two factors, in turn, contributed to a significant decline in U.S.-produced varieties. With surviving domestic establishments being forced to increase their scale of production, as highlighted in Table 2, the number of establishments typically fell for a given market size. Notably, an increasing scale could, in principle, indicate more varieties produced per establishment. Yet the decisive decline in employment observed in U.S. manufacturing for the period under consideration suggests that, on average, the fall in the number of domestic varieties implied by our analysis is quite realistic.

Some sectors such as chemical products or transportation equipment are notable exemptions as reported in Table 4. In these two industries the change in domestic varieties complements the gains from imported varieties. Thus, imported and domestically produced varieties need not be substitutes at the individual sector level. Our results for transport equipment, for example, are in line with the recent findings by Blonigen and Soderbery (2010), who focus on the U.S. automobile sector. For a similar observation period to ours, they report considerable gains both from imported and domestic varieties in the U.S. automobile market. In their study, foreign-owned affiliates add an extra 70% to the variety gains in this sector. The results presented in Table 4 should, however, make us cautious when drawing any conclusions for U.S. manufacturing as a whole based on analyses of individual sectors.

4.3. Using “Business Dynamics” Data to Allow for Differences in Domestic Expenditures

So far, equal expenditure shares for new, disappearing, and common varieties have been assumed. Neglecting potential differences in these shares, however, is likely to overstate the importance of new and disappearing varieties as, for example, shown by Arkolakis et al. (2008) for Costa Rica. They find that new and disappearing varieties

have, on average, lower expenditure shares than existing varieties.¹¹ In the same vein, Broda and Weinstein (2006, p. 567) show that in the United States gains from imported varieties become more than two times larger if a count measure is used instead of the lambda ratio in equation (2), which weights varieties according to their expenditure share. These findings suggest checking the robustness of our results by allowing for differences in expenditures.

Whereas trade data provide the necessary information to compute the lambda ratios as defined in (2), our domestic production data do not allow the computation of the corresponding theta ratio, as we cannot identify each domestic variety's expenditure share. However, employment data of new and disappearing establishments provide evidence on the relative importance of these establishments, which, in our analysis, are defined as domestic varieties. Figure 1 plots the aggregated annual employment of new and disappearing varieties as a share of total employment in U.S. manufacturing from 1993 to 2006. The data stem from the U.S. Small Business Administration (SBA) and are available at the 4-digit NAICS level.¹² We compare these employment shares with the shares of the number of new and disappearing establishments relative to that of all domestic establishments, i.e. the count data.¹³

Insert Figure 1 approximately here

Assuming that the employment share is a suitable proxy for the expenditure share, our result confirms the necessity of allowing for differences in expenditures shares. Figure 1 illustrates that new establishments, on average, account for 7.7% of the total number of establishments per year, but only for 2.5% of employment. Similarly, 8.6%

¹¹Several reasons may be responsible for this observation. The authors attribute this to the inferior productivity of marginal firms. They refer to the limited impact of these varieties on welfare gains from trade as high “curvature”.

¹²This dataset is based on the Statistics of U.S. Businesses (SUSB) released by the U.S. Census. Data are collected each year in March. Entry (exit) data assigned to 1993, for example, include establishments entering (exiting) between March 1992 and March 1993.

¹³Since the SBA data are only available up until the year 2006, our estimates in the remainder of this paper are based on the observation period from 1992 to 2006 instead of 2007.

of the total number of establishments disappears each year, but these, on average, only account for 3.5% of employment.

Note, however, that the SBA dataset with its yearly exits and entries of establishments is not sufficient to compute the requested theta ratios. In order to estimate the gains from variety, we need to distinguish between (i) varieties present both in the first (1992) and last (2006) year of observation (the common set); (ii) those present in the last but not in the first year (new varieties); and (iii) those present in the first but not in the last year (disappearing varieties). This requires the identification and elimination of “temporary varieties”, i.e. those appearing after 1992 and disappearing before 2006. In other words, we have to come up with two estimates. First, we need an estimate of the expenditures in 2006 on all varieties that entered after 1992 and did not exit before 2006. Second, we need an estimate of the expenditures in 1992 on all varieties that existed in 1992, but disappeared at some stage between 1993 and 2005. With this information in hand, we can then calculate the expenditures on the common set and thus the theta ratios as defined in (2). This, however, requires tracking the evolution of the new and disappearing varieties’ expenditure shares over the entire period of time.

The U.S. Census’ Business Dynamics Statistics (BDS) database permits the retrieval of this information at the total manufacturing level up until 2005. The BDS data allow one to track how all entering establishments in a specific year, defined as a cohort, develop over time.¹⁴ The database records the number of surviving and exiting establishments in the cohort as well as the number of employees working for the establishments of the cohort. We therefore know how the number of employees evolves year by year for any cohort. In Figure 2, we plot the ratio of the cohorts’ employees in year x after entry as compared to the cohorts’ number of employees in their year of entry¹⁵ According to this analysis, for example, 74% and 67% of the jobs created

¹⁴The dataset only records entering establishments of new firms; new establishments of existing firms are not covered. However, the former account for about 75% of all entering establishments.

¹⁵The BDS dataset’s coverage ends in 2005. Hence, we are not able to capture the cohorts’ evolution

by establishments entering in a given year still remain active after 6 and 13 years, respectively. Job destruction is thus far less pronounced than the decline in the number of establishments, i.e. the establishment survival rate, because many of the surviving establishments expand their workforce.

Insert Figure 2 approximately here

We take these figures and combine them with the annual data on actual entrants in the SBA dataset. This allows us to predict the number of employees in 2006 that work in an establishment that had entered after 1992. This is exactly the information required to calculate θ_{hst} . Figure 3 illustrates how new establishments represent a considerable employment share in the year 2006, about 31%. Specifically, we start with the cohort entering in 1993 that accounts for 3% of total employment, the new establishments' employment share in 1993. For the year 1994, we conclude from our first-year estimate in Figure 2 that the number of employees working for the 1993-cohort stands at some 97% of its initial level. These employees together with the employees from the cohort entering in 1994 add up to the new establishments' employment in 1994. We depict the new establishments' share relative to total manufacturing employment in 1994 in Figure 3, some 5%. We proceed in this manner up until 2006, the final year of observation.

Insert Figure 3 approximately here

An analogous approach is used to approximate the expenditures in 1992 of disappearing varieties, i.e. those establishments available in 1992, but no longer in 2006. We define the “exiting cohort” of the year 2005 as the set of establishments exiting in 2005. The number of establishments included in this cohort *declines* as we move *back*

in 2006. To address this shortcoming, we employ averages over all entering cohorts for each year x after entering, allowing us to extend our proxy of the evolution of cohorts to the year 2006.

in time. In 2004, this cohort includes all establishments present in 2004 that exit in 2005. In 2003, this cohort is smaller than in 2004 since some establishments that will exit in 2005 do not exist *yet*, i.e. establishments that will enter in 2004 and exit in 2005. The BDS data allow us to infer this cohort’s employment in any given year and to assign the number of employees within the cohort to establishments of a given age.

In Figure 4, we depict the number of employees of establishments of “exiting cohorts” that already existed x years earlier relative to the total number of employees of all establishments of this cohort at the time of exit. Note that this is the same concept as in Figure 2, simply using a reversed time axis. Taking cohort averages from observations over the period from 1992 to 2005, we can infer that, for example, 75% and 65% of the employment lost due to exiting establishments in a given year is attributable to establishments already active at least 6 and 13 years earlier, respectively. Taking the case of the cohort that exits in 1998 as an example, our estimates imply that 75% of the employment destroyed due to its exit can be attributed to establishments that already existed in 1992, i.e. disappearing varieties. All the other establishments in this cohort, however, represent temporary varieties not to be included in the theta ratio.

Insert Figure 4 approximately here

We combine the ratios in Figure 4 with the data on annual job destruction from the SBA dataset. This yields our estimate of the employment share, relative to total employment in 1992, of establishments active in 1992 but exiting at some time before 2006. According to Figure 5, establishments having disappeared by 2006 account for about 36% of total 1992 employment. This estimate serves as our proxy of the disappearing varieties’ expenditure share. The figure is best read from right to left: The last exiting cohort in our observation period exits in 2005. Its job losses account for approximately 3% of total 2005 employment. In 2004, the employment share of disappearing establishments (i.e. having exited before 2006) includes those exiting in 2004 as well as 95% (from Figure 4) of the future layoffs in 2005. This amounts to

about 7% of total 2004 employment. We repeat the process up until 1992, our first year of observation.

Insert Figure 5 approximately here

Our analysis not only offers a concrete estimate for the average expenditure shares of new and disappearing varieties of U.S. manufacturing that will be used in the next subsection. It also confirms the relevance of going beyond an approach based on count data. While new varieties initially have relatively small expenditure shares, those which survive grow significantly over the years.

One may ask whether the employment shares used in our approach are a suitable proxy for the expenditure shares in the theta ratios. We argue that this is the case as long as labor productivity does not systematically and substantially differ between new, exiting and incumbent establishments. As shown by Caves (1998) in a survey of research performed with data from the 1960s to the mid-1990s, this assumption seems to hold for new and exiting establishments. Thus, our measure does not distort the relative importance of new and exiting establishments. Yet, small productivity differentials are found between these establishments and incumbent ones. Labor productivity in new establishments, however, picks up quickly and reaches the sector average after a few years. Furthermore, exiting establishments exhibit a gradual decline in their labor productivity level over time. This pattern is observed for several countries and seems to be robust over time.¹⁶ Hence, given that the set of new varieties in our measure includes all establishments active in 2006 but which entered after 1992, we can expect the bulk of new establishments to have reached the incumbents' productivity levels by 2006. Disappearing varieties include establishments active in 1992 that exit at some point before 2006. We can therefore consider a considerable share of these establishments to

¹⁶A recent study by Wagner (2010) observes similar dynamics for German manufacturing industries from 1995 to 2002.

have productivity levels close to the sector average in 1992.¹⁷ Thus, we feel comfortable with our proposed measure.

4.4. *Re-Estimating the Gains from Variety*

Employing the new and disappearing varieties' expenditure shares, we compute the gains from variety as defined in equations (3) and (4) for each sector at the 4-digit NAICS level, the highest level of disaggregation available in the SBA dataset, from 1992 to 2006 using the elasticities presented in Table 3. In Table 5, we compare our new estimates ("Weighted estimates" with sector-specific σ_s , second row) to those in Section 4.2 ("Count data", first row).

Our refined measure provides further evidence for a significant reduction in total variety gains due to a domestic variety loss. The domestic variety loss outweighs the imported variety gains as we switch from count data to our weighted estimate. In fact, we find a total loss from trade in variety, which implies that consumers would be willing to pay 1.26% of U.S. GDP to regain access to the set of varieties available to them in 1992.

Insert Table 5 approximately here

Two factors contribute to this result. The first one is the marked decline in imported variety gains from nearly 5% to below 1% as we depart from assuming equal expenditure shares for all varieties. This strong reduction of the gains from imported varieties is supported by the results in Broda and Weinstein (2006). Their findings imply a 60% downward correction which is not fundamentally different from our 80%, taking into account the difference in the period of observation. This correction is due to the fact that new and disappearing imported varieties are typically large in numbers, but small in expenditures. While the count data suggest a dominant role for these

¹⁷Note that general productivity increases in an industry do not bias our measure, since the ratio of employment shares is relevant. Hence, overall productivity increases cancel out in this expression.

new and disappearing varieties, their influence is put into perspective as soon as we appropriately weight them with their expenditure shares.

The second factor for the result is the persistent domestic variety loss. Accounting for differences in expenditure shares has a considerably weaker impact on domestic than on imported varieties. The loss is reduced, but only by 33% in absolute value when moving from count data to weighted estimates. To provide some intuition for this result, we compare the change in varieties based on count data (see Tables 1 and 2) with the change implied by the lambda and theta ratios in (2).¹⁸ While we find imported varieties to rise by 44% from 1992 to 2006 using count data, the lambda ratios proposes a mere 19% increase. For domestic varieties, count data reveal an 11% decline, whereas the theta ratios suggest a 6% fall. Since the count data overstate the change in varieties relatively more for imports (2.3 times) than for domestic production (1.8 times), the switch from the count to the weighted measure comes with a larger downward correction for imported than for domestic varieties.¹⁹

Since the BDS data are only available at the total manufacturing level, we have to rely on a single approximation of the evolution of new and disappearing establishments' employment, as illustrated in Figures 2 and 4. Although we apply this approximation to the sector-specific information on gross employment entry and exit per sector, we cannot rule out that additional sector-specific factors influence employment developments. Not accounting for the latter may bias the results in one or the other direction. Taking a single elasticity for all manufacturing sectors instead may better correspond to the level of aggregation in the BDS data. This, however, leaves aside additional sector-specific information from the SBA data that we currently use. In addition, the selection of a representative elasticity can hardly account for the pronounced skewness

¹⁸Specifically, we compute one single lambda ratio and one single theta ratio to obtain a variety measure for the overall manufacturing sector for imports and domestic production, respectively.

¹⁹In the terminology of Arkolakis et al. (2008) this result suggests a higher curvature in the import data compared to the domestic production data.

in the distribution of estimated elasticities at the sector level.

As a sensitivity analysis, we test whether the results depend on our assumption regarding the elasticity of substitution. The last two rows in Table 5 present the gains assuming a single elasticity of substitution for all varieties. Thereby, we distinguish between the weighted mean and the median of the elasticities estimated in Section 4.1. We find that the latter specification leads to an even stronger total loss from varieties. As argued in Broda and Weinstein (2006, p. 577), the median however tends to underestimate the elasticity for the industry aggregate and therefore overestimates the impact of changes in the number of varieties. This implies that this specification is likely to overemphasize gains from imported varieties and losses from domestic varieties. The observed estimates of 1.82% and -3.16% in Table 5 are, in fact, in line with this reasoning. Applying the weighted mean of the elasticity of substitution, which is higher than the median, results in a welfare loss of 0.95%, slightly lower than our benchmark result of -1.26%. The existence of a loss from domestic varieties proves to be robust to this change in the specification. Nevertheless, we argue in favor of employing sector-specific elasticities to take advantage of the additional information in the distribution of these elasticities available in our data set.

In sum and across the different specifications, we find evidence for a substantial downward correction in the gains from imported varieties due to a considerable loss of domestic varieties. Neglecting the adjustment in the domestic variety set will therefore lead to a considerable overestimation of the total gains from variety in U.S. manufacturing.

5. Conclusions

This paper started from the presumption that the gains from variety may be overstated if the trade-induced change in the variety of domestic production is neglected in the analysis. Even though recent research has tried to incorporate this aspect to

some degree, we argue that a major adjustment of firms in the scale of production or intensive margin is largely overlooked—a point which has also been stressed by Bernard et al. (2009).

We address this issue by proposing a direct variety measure for domestic production, equal to the number of active establishments in a sector. Taking data on the value of shipments, we are able to distinguish between changes in the intensive and the extensive margin in a sector over time. We use this measure in combination with the country-of-origin based definition of imported varieties, which is well-established in the literature. Using the methodology developed by Feenstra (1994), we estimate the total gains from variety in manufacturing for the United States from 1992 to 2006 and decompose these gains into the gains from imported and the gains from domestic varieties.

The definition of a variety is critically important to this analysis. Our selection reflects the limitations of the data, if we want to assess the gains from variety for a significant part of the economy. Taking active establishments as a proxy for domestic varieties allows us to examine all U.S. manufacturing sectors. Notably, the widely used Armington assumption which we employ to define imported varieties does not apply perfectly to the domestic data. Based on our domestic variety definition, however, we observe plausible and common characteristics regarding the importance and dynamics of the expenditure shares of new and disappearing varieties in the data. These characteristics are also common in import data.

Our analysis proceeds in two steps. In a first step, we estimate these gains based on count data and show that ignoring the adjustment in domestic production may lead to a significant overestimation in the gains from variety. In a second step, we refine our estimate by approximating the expenditure share of new and disappearing varieties. Based on this weighted estimation, we observe a marked decline in the gains from imported varieties to about 1%, while the domestic variety loss drops to 2.2%,

resulting in a net loss of 1.3% of U.S. GDP. Hence, this results confirms the importance of weighted estimations of both, imported and domestic variety gains.

It is important to note that our results should not be considered an argument in favor of restricting imports or international trade. While we do find a strong decline in domestic variety as well as evidence that this decline is, in part, due to fiercer import competition, this development is most likely to be nevertheless beneficial to the entire U.S. economy. As emphasized in the international trade literature, the reallocation of resources, spurred by international trade, is a cornerstone of productivity and welfare growth. Our findings suggest, however, that an accurate measure of the gains attributed to an increase in the set of available varieties should rest on a comprehensive analysis of adjustments in the composition of both imports and domestic production.

References

- Ardelean, A., Lugovskyy, V., 2010. Domestic productivity and variety gains from trade. *Journal of International Economics* 80 (2), 280–291.
- Arkolakis, C., Demidova, S., Klenow, P. J., Rodríguez-Clare, A., 2008. Endogenous variety and the gains from trade. *American Economic Review* 98 (2), 444–450.
- Armington, P. S., 1969. A theory of demand for products distinguished by place of production. *International Monetary Fund Staff Papers* 16, 159–178.
- Baldwin, R. E., Forslid, R., 2010. Trade liberalization with heterogeneous firms. *Review of Development Economics* 14 (2), 161–176.
- Bernard, A. B., Eaton, J., Jensen, J. B., Kortum, S. S., 2003. Plants and productivity in international trade. *American Economic Review* 93 (4), 1268–1290.
- Bernard, A. B., Jensen, J. B., Redding, S. J., Schott, P. K., 2009. The margins of US trade. *American Economic Review* 99 (2), 487–93.

- Bernard, A. B., Jensen, J. B., Schott, P. K., 2006. Survival of the best fit: Exposure to low-wage countries and the (uneven) growth of U.S. manufacturing plants. *Journal of International Economics* 68, 219–237.
- Blonigen, B. A., Soderbery, A., 2010. Measuring the benefits of foreign product variety with an accurate variety set. *Journal of International Economics* 82 (2), 168–180.
- Broda, C., Weinstein, D. E., 2006. Globalization and the gains from trade. *Quarterly Journal of Economics* 121 (2), 541–585.
- Broda, C., Weinstein, D. E., 2010. Product creation and destruction: Evidence and price implications. *American Economic Review* 100 (3), 691–723.
- Caves, R. E., 1998. Industrial organization and new findings on the turnover and mobility of firms. *Journal of Economic Literature* 36 (4), 1947–1982.
- Deitz, R., Orr, J., 2006. A leaner, more skilled U.S. manufacturing workforce. *Current Issues in Economics and Finance* (Feb/Mar).
- Diewert, W. E., 1976. Exact and superlative index numbers. *Journal of Econometrics* 4 (2), 115–145.
- Eaton, J., Kortum, S., Kramarz, F., 2008. An anatomy of international trade: Evidence from french firms. NBER Working Paper 14610.
- Ebenstein, A., Harrison, A., McMillan, M., Phillips, S., 2009. Estimating the impact of trade and offshoring on American workers using the current population surveys. NBER Working Paper 15107.
- Feenstra, R. C., 1994. New product varieties and the measurement of international prices. *American Economic Review* 84 (1), 157–177.
- Feenstra, R. C., 2010. Measuring the gains from trade under monopolistic competition. *Canadian Journal of Economics* 43 (1), 1–28.

- Forbes, K., 2004. U.S. manufacturing: Challenges and recommendations. *Business Economics* 39 (3), 30–37.
- Grubel, H. G., Lloyd, P. J., 1975. *Intra-Industry Trade: The Theory and Measurement of International Trade in Differentiated Products*. Wiley, New York.
- Helpman, E., Krugman, P. R., 1985. *Market Structure and Foreign Trade*. The MIT Press, Cambridge, Massachusetts.
- Krugman, P. R., 1979. Increasing returns, monopolistic competition, and international trade. *Journal of International Economics* 9 (4), 469–479.
- Krugman, P. R., 1980. Scale economies, product differentiation, and the pattern of trade. *American Economic Review* 70 (5), 950–959.
- Melitz, M. J., 2003. The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica* 71 (6), 1695–1725.
- Mohler, L., 2011. Variety gains from trade in Switzerland. *Swiss Journal of Economics and Statistics*, Forthcoming.
- Mohler, L., Seitz, M., 2010. The gains from variety in the European Union. Munich Discussion Paper 2010-24.
- Pierce, J. R., Schott, P. K., 2009. A concordance between ten-digit U.S. harmonized system codes and SIC/NAICS product classes and industries. NBER Working Papers 15548.
- Sato, K., 1976. The ideal log-change index number. *Review of Economics and Statistics* 58 (2), 223–228.
- Schott, P. K., 2008. The relative sophistication of Chinese exports. *Economic Policy* 23, 5–49.

Vartia, Y. O., 1976. Ideal log-change index numbers. *Scandinavian Journal of Economics* 3 (3), 121–126.

Wagner, J., 2010. Entry, exit and productivity: Empirical results for German manufacturing industries. *German Economic Review* 11 (2), 78–85.

A. Derivation of the Exact Price Index

The utility C_{st} of good s from the set of consumed goods, S , is composed of the subutility of two composite goods with C_{fst} , consisting of imported varieties, v , and C_{hst} , consisting of domestic varieties, u :

$$C_{st} = \left\{ C_{fst}^{(\epsilon_s-1)/\epsilon_s} C_{hst}^{(\epsilon_s-1)/\epsilon_s} \right\}^{\epsilon_s/(\epsilon_s-1)} ; \quad \sigma_s > \epsilon_s > 1 \quad \forall s \in S, \quad (6)$$

where

$$C_{fst} = \left(\sum_{v=1}^{N_{fs}} d_{fst}^{1/\sigma_s} q_{fst}^{(\sigma_s-1)/\sigma_s} \right)^{\sigma_s/(\sigma_s-1)}, \quad (7)$$

$$C_{hst} = \left(\sum_{u=1}^{N_{hs}} d_{hst}^{1/\sigma_s} q_{hst}^{(\sigma_s-1)/\sigma_s} \right)^{\sigma_s/(\sigma_s-1)}. \quad (8)$$

Whereas ϵ_s defines the elasticity of substitution between imported and domestic varieties of good s , σ_s defines the elasticity of substitution within domestic varieties and within imported varieties of good s . q_{fst} and q_{hst} are the quantities consumed of variety v and u , respectively. N_{fs} and N_{hs} are the sets of potentially available. d_{fst} and d_{hst} are taste or quality parameters specific to each variety. The unit-cost function for every good s can be written as

$$\phi_{st}(I_{fst}, I_{hst}) = \left\{ \left[\left(\sum_{v \in I_{fst}} d_{fst} p_{fst}^{1-\sigma_s} \right)^{1/(1-\sigma_s)} \right]^{1-\epsilon_s} \left[\left(\sum_{u \in I_{hst}} d_{hst} p_{hst}^{1-\sigma_s} \right)^{1/(1-\sigma_s)} \right]^{1-\epsilon_s} \right\}^{1/(1-\epsilon_s)}, \quad (9)$$

where I_{fst} and I_{hst} are the sets of imported and domestic varieties consumed at time t , and p_{fst} and p_{hst} are the unit prices of the varieties. These unit-cost functions are the building blocks of the price index. Diewert (1976) defines an *exact* price index for

consumers with homothetic preferences to be equal to the fraction of the unit-costs.²⁰ Sato (1976) and Vartia (1976) have derived the exact price index for a CES unit-cost function and constant sets of varieties, in our case I_{fs} and I_{hs} , called the “common sets”:

$$P_s(I_{fs}, I_{hs}) = P_{fs}^{\omega_{fst}} P_{hs}^{\omega_{hst}} = \left[\prod_{v \in I_{fs}} \left(\frac{p_{fsvt}}{p_{fsvt-1}} \right)^{\omega_{fsvt}} \right]^{\omega_{fst}} \left[\prod_{u \in I_{hs}} \left(\frac{p_{hsut}}{p_{hsut-1}} \right)^{\omega_{hsut}} \right]^{\omega_{hst}}, \quad (10)$$

where the ω 's represent the ideal log-change weights of imports and domestic production in sector s

$$\begin{aligned} \omega_{fsvt} &= \frac{(s_{fsvt} - s_{fsvt-1}) / (\ln s_{fsvt} - \ln s_{fsvt-1})}{\sum_{v \in I_{fs}} (s_{fsvt} - s_{fsvt-1}) / (\ln s_{fsvt} - \ln s_{fsvt-1})}, \\ \omega_{hsut} &= \frac{(s_{hsut} - s_{hsut-1}) / (\ln s_{hsut} - \ln s_{hsut-1})}{\sum_{u \in I_{hs}} (s_{hsut} - s_{hsut-1}) / (\ln s_{hsut} - \ln s_{hsut-1})}, \\ \omega_{fst} &= \frac{(s_{fst} - s_{fst-1}) / (\ln s_{fst} - \ln s_{fst-1})}{(s_{fst} - s_{fst-1}) / (\ln s_{fst} - \ln s_{fst-1}) + (s_{hst} - s_{hst-1}) / (\ln s_{hst} - \ln s_{hst-1})}, \\ \omega_{hst} &= \frac{(s_{hst} - s_{hst-1}) / (\ln s_{hst} - \ln s_{hst-1})}{(s_{fst} - s_{fst-1}) / (\ln s_{fst} - \ln s_{fst-1}) + (s_{hst} - s_{hst-1}) / (\ln s_{hst} - \ln s_{hst-1})}, \end{aligned}$$

with

$$\begin{aligned} s_{fsvt} &= \frac{e_{fsvt}}{\sum_{v \in I_{fs}} e_{fsvt}}, \\ s_{hsut} &= \frac{e_{hsut}}{\sum_{u \in I_{hs}} e_{hsut}}, \\ s_{fst} &= \frac{e_{fst}}{e_{fst} + e_{hst}}, \\ s_{hst} &= \frac{e_{hst}}{e_{fst} + e_{hst}}. \end{aligned}$$

e_{fsvt} (e_{hsut}) represents the consumer's expenditure on the imported (domestic) variety v (u) at time t , whereas e_{fst} (e_{hst}) represents the expenditure on all imported (domestic)

²⁰It is a remarkable feature that the price index does not depend on taste parameters. The intuition for this result, shown by Diewert (1976), is that all the information contained in the taste parameters is captured by the expenditure shares.

varieties of good s , or equivalently sector s , at time t . Therefore, $s_{fst} (s_{hst})$ stands for the expenditures on imported (domestic) varieties relative to total expenditure in this sector. The price index follows as the geometric mean of all price changes. The exact price index in (10) is subject to a constant variety set. Feenstra (1994) overcomes this constraint by deriving the exact price index for a non-constant variety set of imports, I_{fst} . His result carries over to the case considered here, namely the distinction between imported and domestically produced varieties, as shown by Ardelean and Lugovskyy (2010):

$$\Pi_s = P_s \left(\frac{\lambda_{fst}}{\lambda_{fst-1}} \right)^{\frac{\omega_{fst}}{\sigma_s-1}} \left(\frac{\theta_{hst}}{\theta_{hst-1}} \right)^{\frac{\omega_{hst}}{\sigma_s-1}}. \quad (11)$$

with

$$\lambda_{fst} = \frac{\sum_{v \in I_{fs}} e_{fsvt}}{\sum_{v \in I_{fst}} e_{fsvt}} \quad \text{and} \quad \theta_{hst} = \frac{\sum_{u \in I_{hs}} e_{hsut}}{\sum_{u \in I_{hst}} e_{hsut}}. \quad (12)$$

The derivation of this result is available from the appendix of Feenstra's contribution. Intuitively, the above expression treats varieties that are not available as being priced at their reservation prices. New varieties can then be thought of as experiencing a price fall from their reservation price to their observed price level, which, in turn, lowers the price index.

B. Tables

Table 1: Descriptive Statistics 3-Digit NAICS Industries, Imports 1992-2007

NAICS	Description	Extensive	Intensive	Total
311	Food	47.63%	34.44%	98.48%
312	Beverage and Tobacco	27.71%	144.68%	212.49%
313	Textile Mills	55.02%	-5.83%	45.99%
314	Textile Product Mills	57.92%	231.93%	424.20%
315	Apparel	52.26%	52.95%	132.87%
316	Leather Products	51.88%	20.21%	82.57%
321	Wood Products	-19.70%	-25.91%	-40.50%
322	Paper	54.84%	16.57%	80.50%
323	Printing and Related	17.04%	38.11%	61.65%
324	Petroleum and Coal Products	103.45%	7.88%	119.49%
325	Chemical Products	24.73%	205.63%	281.22%
326	Plastics and Rubber Products	71.86%	81.33%	211.64%
327	Nonmetallic Mineral Products	32.61%	76.13%	133.57%
331	Primary Metal	30.46%	55.95%	103.45%
332	Fabricated Metal Products	42.44%	166.21%	279.19%
333	Machinery	43.61%	151.66%	261.40%
334	Computer and Electronic Products	17.88%	0.05%	17.94%
335	Electrical Equipment	42.21%	211.31%	342.71%
336	Transportation Equipment	45.22%	55.30%	125.53%
337	Furniture	39.89%	322.12%	490.50%
All Manufacturing		43.69%	61.47%	132.02%

Relative changes in real terms. Expenditures on varieties of different product categories have been adjusted for inflation using import price indices available from the BLS.

Table 2: Descriptive Statistics 3-Digit NAICS Industries, Domestic Production 1992-2007

NAICS	Description	Extensive	Intensive	Total
311	Food	-3.27%	4.82%	1.39%
312	Beverage and Tobacco	40.80%	-29.27%	-0.41%
313	Textile Mills	-25.99%	-22.13%	-42.37%
314	Textile Product Mills	-16.22%	-0.45%	-16.60%
315	Apparel	-65.49%	-25.93%	-74.44%
316	Leather Products	-28.62%	-32.07%	-51.51%
321	Wood Products	-2.58%	-9.68%	-12.01%
322	Paper	-15.24%	-3.81%	-18.47%
323	Printing and Related	-39.86%	1.59%	-38.90%
324	Petroleum and Coal Products	8.49%	0.48%	9.01%
325	Chemical Products	4.11%	4.47%	8.77%
326	Plastics and Rubber Products	-14.30%	16.56%	-0.10%
327	Nonmetallic Mineral Products	2.64%	-13.79%	-11.51%
331	Primary Metal	7.25%	-14.03%	-7.80%
332	Fabricated Metal Products	2.64%	-2.20%	0.37%
333	Machinery	-14.62%	18.85%	1.48%
334	Computer and Electronic Products	-16.25%	216.65%	165.18%
335	Electrical Equipment	-11.57%	0.98%	-10.70%
336	Transportation Equipment	-0.70%	14.01%	13.21%
337	Furniture	1.88%	0.52%	2.41%
All Manufacturing		-10.68%	23.51%	10.32%

Relative changes in real terms. Expenditures on varieties of different sectors have been adjusted for inflation using sectoral price indices available from the BLS.

Table 3: Elasticities of Substitution for NAICS Manufacturing Sectors

Statistic	6-digit	4-digit	3-digit
Number	348	83	20
Mean	3.14	2.77	2.17
Median	2.44	2.21	2.08

Estimated from U.S. bilateral trade data. Manufacturing Sectors are defined according to NAICS 6-, 4-, and 3-digit. Varieties are defined as 10-digit HTS product-country pairs.

Table 4: Variety Gains from Imports and Domestic Production Using Count Data 1992-2007

NAICS	Description	Imports	Domestic	Total
311	Food	0.60%	1.13%	1.74%
312	Beverage and Tobacco	0.64%	7.60%	8.29%
313	Textile Mills	5.48%	-17.71%	-13.19%
314	Textile Product Mills	8.92%	-11.92%	-4.06%
315	Apparel	12.94%	-14.34%	-3.26%
316	Leather Products	16.34%	-4.60%	10.99%
321	Wood Products	-2.10%	-0.41%	-2.50%
322	Paper	3.14%	-9.58%	-6.73%
323	Printing and Related	2.61%	-30.95%	-29.15%
324	Petroleum and Coal Products	4.77%	-13.08%	-8.93%
325	Chemical Products	1.72%	8.53%	10.40%
326	Plastics and Rubber Products	4.16%	-11.51%	-7.83%
327	Nonmetallic Mineral Products	4.98%	-5.42%	-0.71%
331	Primary Metal	2.53%	5.50%	8.17%
332	Fabricated Metal Products	4.24%	-6.53%	-2.57%
333	Machinery	6.17%	-2.90%	3.09%
334	Computer and Electronic Products	1.34%	-10.57%	-9.37%
335	Electrical Equipment	9.50%	-3.28%	5.91%
336	Transportation Equipment	4.03%	2.36%	6.49%
337	Furniture	8.26%	-9.64%	-2.18%
All Manufacturing		4.95%	-3.03%	1.77%

Table 5: Variety Gains from Imports and Domestic Production 1992-2006

	Imports	Domestic	Total
Count data*	4.95%	-3.03%	1.77%
Weighted estimates			
Sector-specific, σ_s	0.96%	-2.20%	-1.26%
Weighted mean, $\sigma = 3.11$	1.24%	-2.17%	-0.95%
Median, $\sigma = 2.44$	1.82%	-3.16%	-1.39%

*Includes data from 1992 to 2007.

C. Figures

Figure 1: Shares of Entering and Exiting Varieties, Domestic Production

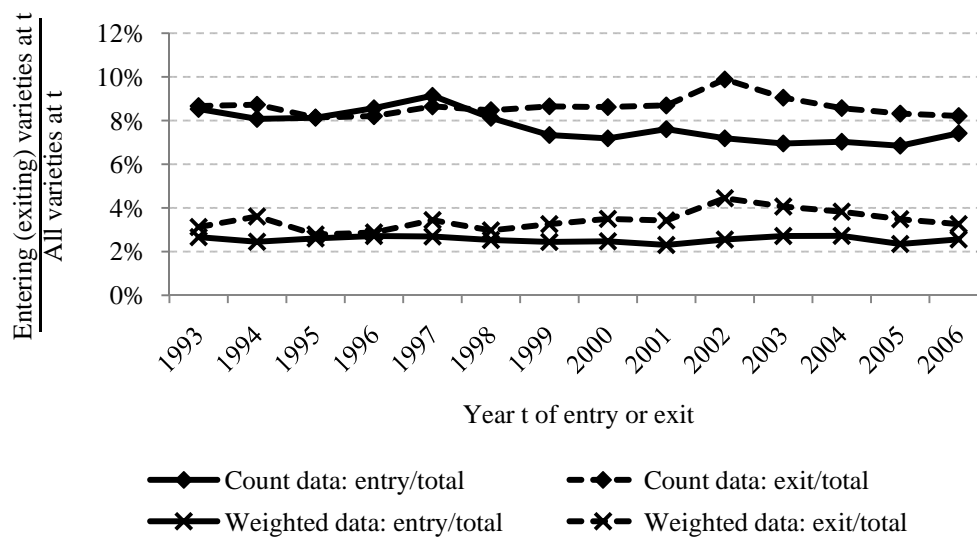


Figure 2: Evolution of Employment of Entering Cohorts After Entry, Averages 1992-2005

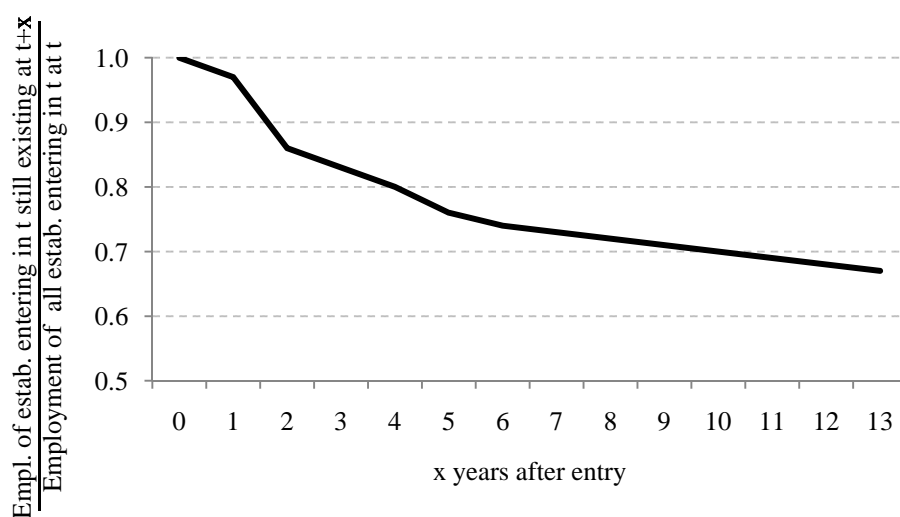


Figure 3: New Varieties' Cumulated Employment Share, Domestic Production

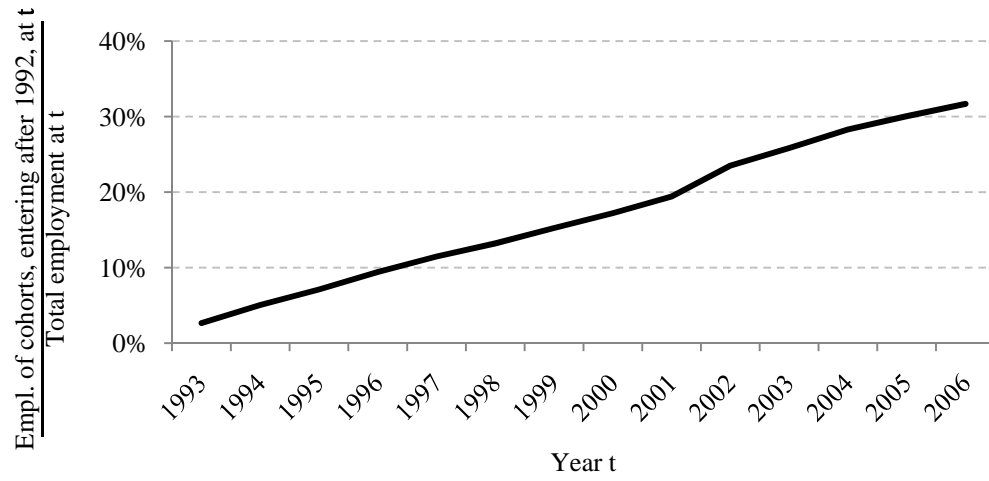


Figure 4: Evolution of Employment of Exiting Cohorts Before Exit, Averages 1992-2005



Figure 5: Disappearing Varieties' Cumulated Employment Share, Domestic Production

