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Gains from trade liberalization with flexible extensive margin adjustment☆

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ABSTRACT

We propose a sufficient statistic to measure the ex-post welfare gains from trade in CES models featuring any productivity distribution and any pattern of selection into production and exporting. This statistic is based on a single data moment, the change in the market share of continuing domestic producers, and a single structural parameter, the elasticity of substitution between products. We apply our statistic to measure Canada's gains from the Canada-US Free Trade Agreement using data on observed firm selection. We find that welfare gains can substantially deviate from welfare estimates implied by formulas that assume a constant extensive margin trade elasticity.

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1. Introduction

Seminal papers by Krugman (1980) and Melitz (2003) show that changes in trade costs can have important effects on welfare by changing the set of firms serving domestic and foreign markets. A large empirical literature has attempted to quantify the “extensive” margin of adjustment to changes in trade costs. For example, Broda and Weinstein (2006) measure the welfare gains from increases in US import variety and Pavcnik (2002) and Melitz and Trefler (2012) measure the effect of trade liberalization on the exit of less productive domestic firms.

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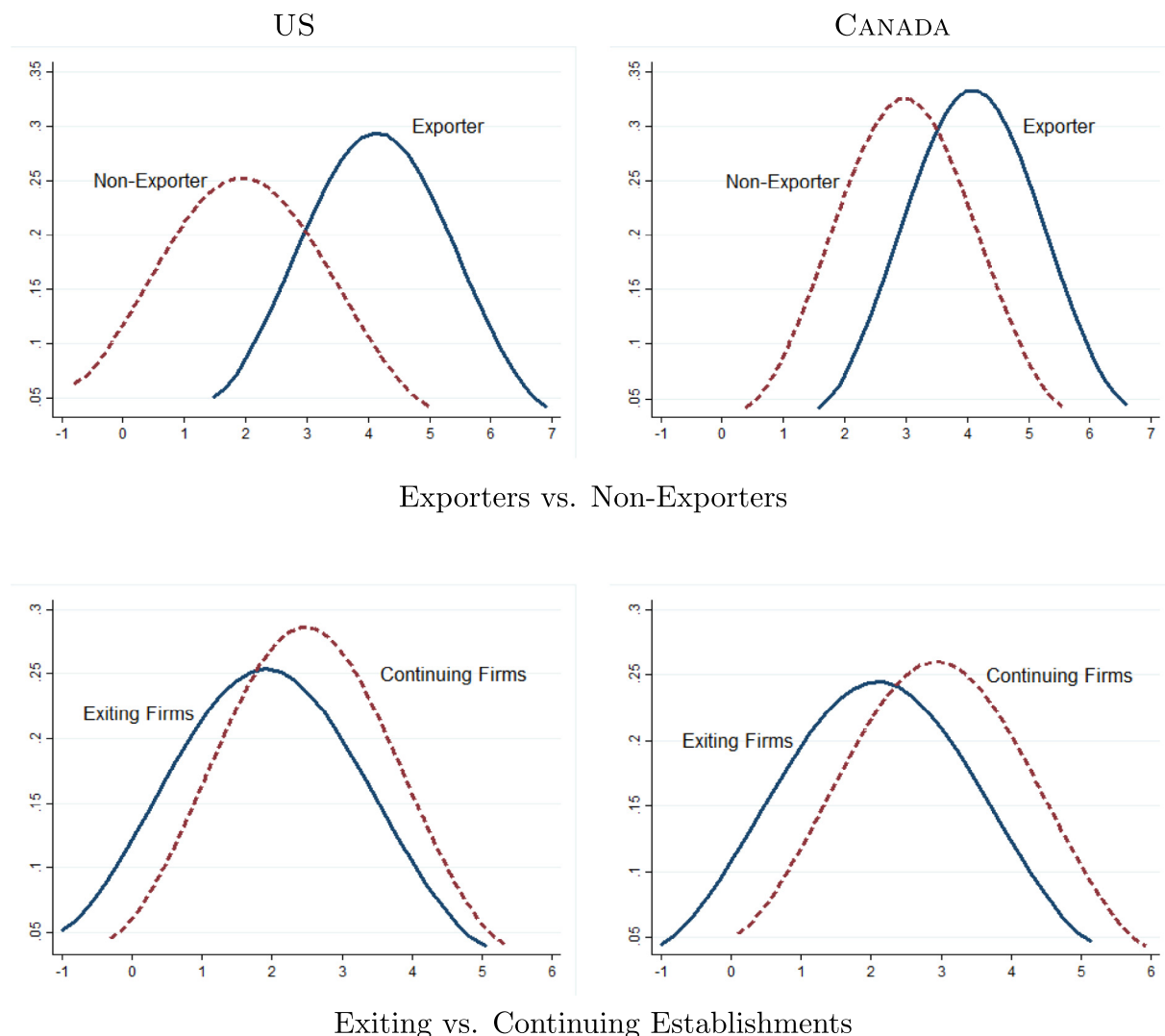


Fig. 1. Distribution of employment.

Note: Top panel shows the distribution of log employment of exporting and non-exporting establishments in Canada in 1996 and the US in 1997. Bottom panel shows distribution of log employment of exiting and continuing establishments in Canada in 1988 and US in 1987. Exiting plants leave the data between 1988 and 1996 (Canada) or between 1987 and 1997 (US). Continuing plants are in the data in the initial and final years. Figures are based on fitting a normal distribution to the 20th, 50th, and 80th percentiles of the relevant statistics calculated from the Canadian and US manufacturing censuses.

However, [Arkolakis et al. \(2012\)](#) (henceforth ACR) show that when import demand is isoelastic, the welfare gains from trade can be calculated from two statistics: the aggregate trade share and trade elasticity. Conditional on these two statistics, it is not necessary to know the magnitude of the extensive margin adjustment to trade, even in models where the extensive margin adjustment is crucial to the welfare effect of trade.

The assumptions necessary to deliver an isoelastic import demand are quite stringent, particularly in models that allow for an extensive margin response to trade. Specifically, in such models, the extensive margin trade elasticity has to be constant. In a [Melitz \(2003\)](#) model this is the case when the distribution of firm productivity is Pareto and there is strict sorting into domestic production and exporting. Recent papers by [Melitz and Redding \(2015\)](#) and [Head et al. \(2014\)](#) consider alternative (non-Pareto) distributions of firm productivity that lead to departures from isoelastic import demand, but maintain the assumption of strict sorting into exports and production.¹

There is, however, abundant evidence that selection into export markets and exit does not follow strict sorting. [Eaton et al. \(2011\)](#) and [Armenter and Koren \(2015\)](#) document substantial overlap in the size distribution of exporters and non-exporters in France and the US. [Fig. 1](#) replicates this evidence for US and Canadian manufacturing for exporters vs. non-exporters (top

¹ [Melitz and Redding \(2015\)](#) calibrate the gains from trade in a Melitz model where the distribution of firm productivity follows a truncated Pareto; [Head et al. \(2014\)](#) do the same assuming a log-normal distribution.

panel) and for surviving vs. exiting firms (bottom panel). Many exporters are smaller (as measured by employment) than non-exporters, and many non-exporters are larger than exporters. Likewise, there is a substantial overlap in the size distribution of surviving vs. exiting firms in the two countries.

This paper introduces a method to measure the gains from trade that is robust to any distribution of firm productivity and any pattern of selection into exporting and domestic production. Our proposed formula is based on one data moment, the domestic market share of continuing domestic producers, and one parameter, the elasticity of substitution between producers. This formula is essentially an application of the well-known Feenstra (1994) formula, albeit one that is very different from what is typically done in the trade literature. The standard application of Feenstra (1994)'s formula is to calculate import variety gains from trade using the expenditure share on continuing imported varieties in all imported varieties as the data moment (e.g., Broda and Weinstein (2006)). Instead, we apply the formula to calculate overall gains from trade using the expenditure share on continuing domestic varieties in all varieties as the data moment.

We illustrate our procedure by using Canadian data to measure the welfare effect on Canada of the Canada-US Free Trade Agreement (CUSFTA). The difference between the gains from trade calculated using our formula and that computed from the ACR statistic depends on the elasticity of substitution between products and the trade elasticity. We do not know for sure the value of these parameters, and when we use the range of empirical estimates from the literature, Canada's gains from the trade agreement computed from the ACR formula could be as much as 9 percentage point higher or 6 percentage point lower than our estimate. However, for our baseline values of 3.72 for the elasticity of substitution across products and 4.7 for the trade elasticity, our estimate of Canada's gain from CUSFTA is half a percentage point lower than indicated by the ACR formula.

Our paper further relates to three sets of papers. First, compared to Melitz and Redding (2015) and Head et al. (2014), our proposed summary statistic works for any distribution of firm productivity and for any pattern of firm entry and exit into exports and production. Second, relative to Hsieh et al. (2020), our focus in this paper is on the overall gains from trade rather than on a decomposition of the foreign and domestic extensive margin responses to trade. Third, Fernandes et al. (2022) and Adao et al. (2020) use firm level data to estimate trade models that allow for flexible extensive margin responses consistent with deviations from isoelastic import demand. Ours is an ex-post measure of the gains from trade and is silent on the structural parameters of the underlying trade model. In contrast, Fernandes et al. (2022) and Adao et al. (2020)'s method yields valuable structural parameters that can be used to conduct ex-ante evaluations.

The paper proceeds as follows. We first derive a sufficient statistic for the gains from trade that holds for all trade models with CES preferences, including those where the import demand elasticity is not constant and firms do not sort into markets based on productivity only. We then use micro-data from Canadian manufacturing to calculate Canada's welfare gains for the 1988 to 1996 period after CUSFTA was signed.

2. Measuring the gains from trade

This section derives our sufficient statistic for the gains from trade liberalization and compares it with other formulas used to quantify welfare in trade settings with CES preferences and an extensive margin response to trade liberalization. We derive this statistic in the context of a generalized Melitz (2003) model where import demand is not necessarily isoelastic. We do this by allowing the productivity distribution to take any form and by not imposing any restriction on selection into production and exporting.

2.1. Model assumptions and derivation

We assume a representative consumer with CES preferences over differentiated varieties. The production technology of each variety is linear in labor $y(\varphi) = \varphi l(\varphi)$, where φ is the productivity of the firm producing the particular variety. Trade frictions between firms producing in country i and shipping to country j are denoted by $\tau_{ij} > 1$ (we assume $\tau_{ij} = 1$ henceforth). Importantly, we make no assumptions about the entry process and instead just denote by M_{ij} the number of firms from country i that offer goods in country j .²

CES utility implies that demand from country j consumers for products offered by firms from country i with productivity φ is given by $q_{ij}(\varphi) = \frac{p_{ij}(\varphi)^{-\sigma}}{P_j^{1-\sigma}} Y_j$ where p_{ij} the delivered price in country j , P_j and Y_j are price index and nominal income in country j , and $\sigma > 1$ is the elasticity of substitution. We assume monopolistic competition so the profit maximizing price is a constant markup over the marginal cost: $p_{ij}(\varphi) = \frac{\sigma}{\sigma-1} \frac{w_i \tau_{ij}}{\varphi}$, where w_i is the wage in the producer's country.

Bilateral trade flows can therefore be expressed as a function of average prices, $X_{ij} = M_{ij} \left(\frac{\tilde{p}_{ij}}{P_j} \right)^{1-\sigma} Y_j$, where average prices are in turn a function of average productivities, $\tilde{p}_{ij} = \frac{\sigma}{\sigma-1} \frac{w_i \tau_{ij}}{\tilde{\varphi}_{ij}}$, where $\tilde{\varphi}_{ij}$ is a weighted harmonic mean of productivity.³

Consider now a shock to the economy, which causes some firms to exit and others to enter. We focus on trade liberalization in our application but our method really applies to any shock. We denote by M_{ij}^c the subset of continuing firms, defined as firms

² In Appendix A, we extend the model to allow for intermediate goods, non-traded goods, and heterogeneous elasticities of substitution across industries.

³ Specifically, $\tilde{\varphi}_{ij} \equiv \left(\int_{\varphi \in \Phi_{ij}} \varphi^{\sigma-1} dG_i(\varphi | \varphi \in \Phi_{ij}) \right)^{\frac{1}{\sigma-1}}$, where Φ_{ij} is the set of productivities corresponding to all country i firms serving country j and $G_i(\varphi | \varphi \in \Phi_{ij})$ is their cumulative distribution.

which are active both before and after the shock. Bilateral trade flows associated with continuing firms can be written as $X_{ij}^c = M_{ij}^c \left(\frac{\tilde{p}_{ij}^c}{p_j}\right)^{1-\sigma} Y_j$, where average prices and average productivity are defined only over this subset of firms, $\tilde{p}_{ij}^c = \frac{\sigma}{\sigma-1} \frac{w_i \tau_{ij}}{\tilde{\varphi}_{ij}^c}$. By definition, there are no changes in the set of continuing firms so that M_{ij}^c remains unchanged and $\tilde{\varphi}_{ij}^c$ changes only if there are within-firm productivity effects (i.e. there are no Melitz-type selection or re-allocation effects on $\tilde{\varphi}_{ij}^c$).

We derive our sufficient statistic by focusing on the domestic market share of *continuing domestic firms*, $\lambda_{jj}^c \equiv \frac{X_{jj}^c}{Y_j}$. Using our expression for X_{ij}^c above, we can express price index changes as $\Delta \ln P_j = \Delta \ln \tilde{p}_{jj}^c + \frac{1}{\sigma-1} \Delta \ln \lambda_{jj}^c$. From our expression for \tilde{p}_{ij}^c above, we know that $\Delta \ln \tilde{p}_{jj}^c = \Delta \ln w_j - \Delta \ln \tilde{\varphi}_{jj}^c$ so that we can write changes in the domestic real wage as $\Delta \ln \frac{w_j}{p_j} - \Delta \ln \tilde{\varphi}_{jj}^c = -\frac{1}{\sigma-1} \Delta \ln \lambda_{jj}^c$. Changes in the domestic real wage are equal to changes in per-capita welfare if labor income is proportional to total income since then $\Delta \ln \frac{w_j}{p_j} = \Delta \ln \frac{Y_j/L_j}{p_j} \equiv \Delta \ln W_j$. This holds, for example, under free entry and we impose this assumption henceforth. We can thus write:

$$\Delta \ln W_j - \Delta \ln \tilde{\varphi}_{jj}^c = -\frac{1}{\sigma-1} \Delta \ln \lambda_{jj}^c \tag{1}$$

We will sometimes refer to (1) as the HLOY welfare statistic. This equation says that anything that affects welfare, other than the productivity of continuing domestic firms, shows up as changes in λ_{jj}^c . One implication of this is that the effect of changes in trade costs on welfare, including the effect of any reallocation and entry and exit induced by the change in trade costs, can be measured by one simple statistic, the change in the domestic market share of continuing domestic firms $\Delta \ln \lambda_{jj}^c$, and one parameter, the elasticity of substitution σ .

We want to make clear three points about our proposed statistic for the gains from trade in eq. (1). First, while it captures all welfare effects from domestic net entry and changes in the price or variety of foreign imports when comparing two equilibria, interpreting it as the welfare gains from trade assumes that all of these changes are brought about by trade. This may not be true. For example, in a closed economy our sufficient statistic boils down to $\frac{1}{\sigma-1} \Delta \ln \lambda_{jj}^c = \frac{1}{\sigma-1} \Delta \ln M_{jj} + \Delta \ln \frac{\tilde{\varphi}_{jj}^c}{\varphi_{jj}^c}$, which is simply the gains from entry of new domestic varieties net of the losses from domestic exit.

Second, even if the changes underlying computation of eq. 1 are driven by trade shocks, we do not know whether they are due to changes in *trade costs*, e.g. import tariff cuts negotiated under CUSFTA. For example, differential productivity growth (domestic vs. foreign) or changes in the fixed cost of exporting can also affect welfare through domestic net entry and changes in the price and variety of foreign imports. Thus while we apply our formula to data on observed trade flows and domestic firm selection during the CUSFTA period in section 3, we acknowledge that these data potentially reflect factors other than reductions in bilateral Canada-US trade costs. These points apply to any welfare comparison across observed equilibria, and highlight that our main contribution is toward measurement of welfare changes in trade models with selection rather than toward identification of trade or trade cost shocks.

Third, while we derived our sufficient statistic in a generalized Melitz (2003) model, it should be clear from our derivations that it holds in all models satisfying $X_{ij} \propto M_{ij} \left(\frac{\tilde{p}_{ij}}{p_j}\right)^{1-\sigma} Y_j$, $\tilde{p}_{ij} \propto \frac{w_i \tau_{ij}}{\tilde{\varphi}_{ij}}$, and $w_i L_j \propto Y_j$. For example, where the formula by ACR holds for an Eaton and Kortum (2002) model with Frechet productivity, our formula holds in a generalized Ricardian model with an arbitrary productivity distribution if M_{ij} is reinterpreted as the number of goods shipped from country i to country j .

2.2. Comparison to other welfare sufficient statistics

2.2.1. Relation to Feenstra (1994)

The formula in eq. (1) is essentially an application of Feenstra (1994), albeit one that is very different from what is typically done in the literature. While prior papers such as Broda and Weinstein (2006) use Feenstra (1994) to measure the *import variety* gains from trade, we apply it to measure the *overall* gains from trade. Feenstra (1994) decomposes price index changes ($\Delta \ln P$) into a term capturing changes in the prices of continuing goods ($\sum_{i \in I^c} \bar{\mu}_i^c \Delta \ln p_i$, where I^c is a subset of continuing goods and $\bar{\mu}_i^c$ are Sato-Vartia weights) and a residual commonly thought of as capturing changes in the set of available goods (the “Feenstra ratio” $\frac{1}{\sigma-1} \Delta \ln \lambda^c$). However, the set I^c can be defined to include any subset of goods available in both periods in which case the Feenstra ratio term *also* captures the welfare effects of changes in the prices of any continuing goods excluded from the chosen set of continuing goods I^c . This includes, for example, changes in the prices of continuing imported goods that result from changes in iceberg trade costs or terms of trade.

Our statistic essentially boils down to choosing the subset of continuing goods that are produced in the home country and recognizing that in many trade models the domestic real wage is fixed in terms of these goods, making additional micro data on prices and domestic wages (or calculation of Sato-Vartia weights) unnecessary to calculate welfare changes. Intuitively, the market share of continuing domestic goods measures the net effect of all the margins of adjustment triggered by a change in trade

costs. In a model with only adjustment on the intensive margin, the share of continuing domestic goods falls when a reduction in trade costs lowers the prices of foreign goods. In models that also have adjustment on the extensive margin, the share of continuing domestic goods also falls with more and better entering foreign varieties and rises with more and better exiting domestic varieties.

Note that in principle our approach allows a researcher to choose any set of continuing goods for which the domestic real wage can be directly measured, or for which changes are expected to be zero. The “Feenstra ratio” in our statistic then captures all welfare relevant changes in variety and/or prices for other goods, including those related to within-firm productivity changes, within-firm product variety changes, changes in quality/taste, and markup changes. For example, if one specifies the set of firms in I^c to include only continuing firms in industries that are not expected to be affected by tariff cuts under CUSFTA, any welfare-relevant changes affecting continuing firms in industries with high tariff cuts will be captured by changes in their market share relative to the firms in I^c (see Hsieh et al. (2020) for some examples). The available CUSFTA data will also allow us to implement this variant of our formula in the next section.

More generally, the appropriate choice when defining the set of continuing varieties for implementing our welfare statistic will depend on (a) the nature of the data on prices and quantities that is available, particularly the level of aggregation, (b) which continuing products, plants or firms have domestic real wage changes that are expected to be invariant to a trade shock or that can be quantified directly, and (c) the desirability of choosing a larger set of continuing varieties to minimize the effect of measurement error and idiosyncratic firm outcomes on the measurement of aggregate welfare.⁴ Our benchmark implementation of eq. (1) in the CUSFTA setting reflects the availability of plant-level data on sales in Canada, the implications of many common trade models that the domestic real wage in terms of continuing domestic producers is invariant to trade shocks, and the large share of domestic consumption that comes from continuing domestic plants.

2.2.2. Relation to gains from trade formulas

Our statistic can also be seen as a generalization of other formulas previously proposed in the literature to quantify the total gains from trade such as those used in Arkolakis et al. (2012), Melitz and Redding (2015) and Head et al. (2014). While we derive our formula based on bilateral trade flows associated with continuing domestic firms, $X_{jj}^c = M_{jj}^c \left(\frac{\tilde{p}_{jj}^c}{p_j}\right)^{1-\sigma} Y_j$, the formulas in Arkolakis et al. (2012), Melitz and Redding (2015) and Head et al. (2014) start from bilateral trade flows associated with all domestic firms, $X_{jj} = M_{jj} \left(\frac{\tilde{p}_{jj}}{p_j}\right)^{1-\sigma} Y_j$. Following the same steps we used to derive our formula yields the following expression:

$$\Delta \ln W_j - \Delta \ln \tilde{\varphi}_{jj} = -\frac{1}{\sigma - 1} (\Delta \ln \lambda_{jj} - \Delta \ln M_{jj}^c)$$

This formula is not immediately implementable since $\Delta \ln \tilde{\varphi}_{jj}$ includes selection effects and $\Delta \ln M_{jj} \neq 0$. In contrast, the productivity term in the HLOY welfare statistic $\Delta \ln \tilde{\varphi}_{jj}^c$ includes only within-firm productivity changes, and the number of continuing domestic firms M_{jj}^c in the HLOY statistic is obviously constant.

Melitz and Redding (2015) make progress by imposing the additional assumption that there is a unique domestic productivity cutoff φ_j^d below which domestic firms exit the domestic market. Recalling the definition of $\tilde{\varphi}_{jj}$ and using the relationship $M_{jj} = M_j^e [1 - G_j(\varphi_j^d)]$, where M_j^e is the number of entrants paying a fixed cost to draw a productivity from the cumulative distribution $G_j(\varphi)$, the above formula can be expressed as in eq. (32) of Melitz and Redding (2015):

$$\Delta \ln W_j = -\frac{1}{\sigma - 1} \Delta \ln \lambda_{jj} + \frac{1}{\sigma - 1} \Delta \ln M_j^e + \frac{1}{\sigma - 1} \Delta \ln \left[\int_{\varphi_j^d}^{\varphi_j^{\max}} \varphi^{\sigma-1} dG_j(\varphi) \right] \tag{2}$$

The challenge in implementing eq. (2) is that it requires that we measure changes in M_j^e , φ_j^d , and the shape of the cumulative distribution $G_j(\varphi)$. Melitz and Redding (2015) and Head et al. (2014) both implement versions of this global welfare statistic for truncated Pareto and log-normal productivity respectively but do so by first estimating and calibrating the parameters of the full structural model, which obviates the need for a sufficient statistic for welfare.

For small trade shocks, a local approximation of eq. (2) can be derived using the properties $\Delta \ln W_j = \Delta \ln \varphi_j^d$ and $\Delta \ln \int_{\varphi_j^d}^{\varphi_j^{\max}} \varphi^{\sigma-1} dG_j(\varphi) = -\gamma(\varphi_j^d) \Delta \ln \varphi_j^d$, where $\gamma(\varphi_j^d)$ is the hazard function of log firm size for the cumulative distribution $G_j(\varphi)$ evaluated at φ_j^d .⁵ Substituting these into eq. (2) for small changes and re-arranging yields:

$$\Delta \ln W_j = -\frac{1}{\sigma - 1 + \gamma(\varphi_j^d)} (\Delta \ln \lambda_{jj} - \Delta \ln M_j^e) \tag{3}$$

⁴ For example, while our statistic could theoretically be applied at the level of individual firms, changes in the overall market share of individual firms are much more likely to be driven by firm-specific demand or productivity shocks than differential trade shocks for one firm versus all of the others.

⁵ Although the local welfare gain is directly given by $\Delta \ln W_j = \Delta \ln \varphi_j^d$, which is much simpler than the local welfare formula in equation (3), we are not aware of any attempts to implement this with data, perhaps because the theoretical notion of a domestic productivity cutoff is less clear cut in real world applications.

This local approximation of welfare changes, which applies for any distribution of firm productivity, appears in [Arkolakis et al. \(2009\)](#) and was also used by [Melitz and Redding \(2015\)](#) and [Head et al. \(2014\)](#). With an estimate of σ and a local estimate of $\gamma(\varphi_j^d)$, one could use eq. (3) to approximate welfare gains from a small trade shock without knowledge of the full cumulative distribution $G_j(\varphi)$. Alternatively, [Melitz and Redding \(2015\)](#) show that the term $\sigma - 1 + \gamma(\varphi_d)$ is equal to the difference between a “partial” trade elasticity and the hazard differential between the domestic and foreign export productivity cutoffs.⁶

Note that regardless of the data and methods used to estimate $\sigma - 1 + \gamma(\varphi_j^d)$, the effects of changes in λ_{jj} on welfare can only be estimated locally unless $\gamma(\varphi_j^d)$ is constant. Furthermore, an estimate of $\Delta \ln M_j^e$ is still needed to implement eq. 3. [Arkolakis et al. \(2012\)](#) show that $\Delta \ln M_j^e = 0$ and $\gamma(\varphi_j^d) = \theta - \sigma - 1$ when firm productivity has a Pareto distribution with shape parameter θ . This greatly simplifies the welfare formula in eq. (3) and allows integration of local changes up to global changes, yielding their global welfare formula:

$$\Delta \ln W_j = -\frac{1}{\epsilon} \Delta \ln \lambda_{jj} \tag{4}$$

where ϵ is an estimate of the partial trade elasticity and can alternatively be derived from the shape of the firm productivity distribution. This formula has the advantage of being easy to implement given observed changes in λ_{jj} , requiring only one parameter that can be estimated or calibrated in several ways. It also has the advantage of being a global formula that can be applied to estimate counterfactual welfare gains from a specific scenario, autarky, which sets $\lambda_{jj} = 1$.

Our sufficient statistic in eq. (1) can be viewed as a generalization of the formula by ACR. Recall that ACR require four “model primitives” - (i) Dixit-Stiglitz preferences, (ii) one factor of production, (iii) linear cost functions, and (iv) perfect or monopolistic competition - and three “macro-level restrictions” - (i) trade is balanced, (ii) aggregate profits are a constant share of aggregate revenues, and (iii) the import demand system is isoelastic (with constant trade elasticity ϵ). Their model primitive (i) immediately implies our first key equation $X_{ij} \propto M_{ij} \left(\frac{\tilde{p}_{ij}}{P_j}\right)^{1-\sigma} Y_j$, while their model primitives (i)-(iv) together yield our second key equation $\tilde{p}_{ij} \propto \frac{w_i \tau_{ij}}{\varphi_{ij}}$. Our third key equation $w_i L_j \propto Y_j$ follows from their macro-level restrictions (i) and (ii) so that we effectively relax their macro-level restriction (iii).

To see the connection between the ACR and HLOY formulas, note that our formula (abstracting from within-firm productivity changes) can be written as follows:

$$\Delta \ln W_j = -\frac{1}{\sigma - 1} \Delta \ln \lambda_{jj} - \frac{1}{\sigma - 1} \Delta \ln \frac{X_{jj}^c}{\bar{X}_{jj}} \tag{5}$$

This version of the formula highlights that without changes in the share of continuing domestic products in total domestic sales (the second term on the right hand side), our formula is identical to the ACR formula in the no extensive margin Armington case where $\epsilon = \sigma - 1$.

We can also use this expression to show the conditions under which our formula and the ACR formula yield identical welfare gains when there is an extensive margin. Setting eqs. 4 and 5 equal and re-arranging yields the condition:

$$\frac{1}{\sigma - 1} - \frac{1}{\epsilon} = -\frac{1}{\sigma - 1} \frac{\Delta \ln \frac{X_{jj}^c}{\bar{X}_{jj}}}{\Delta \ln \lambda_{jj}}$$

When import demand is isoelastic (e.g. Melitz-Pareto), both our formula and the ACR formula yield identical results for the change in welfare, which implies strict global proportionality between (negative) percent changes in the share of continuing domestic firms in total domestic firm sales and percent changes in the domestic expenditure share. The ratio of these changes depends only on the difference between the constant trade elasticity and the intensive margin elasticity.

When import demand is not isoelastic but the conditions for our formula are satisfied, the bias in the ACR statistic depends on the relationship between the parameters σ and ϵ and the data moments in the equation above. [Fig. 2](#) illustrates one scenario for a hypothetical economy (labeled HLOY) that does not feature isoelastic import demand. The figure plots the local elasticity of welfare with respect to the domestic expenditure share against the log domestic expenditure share for this economy. Welfare gains can be derived as the area under the curve.

The welfare elasticity is constant under the isoelastic import demand assumption and equal to $\frac{1}{\sigma - 1}$ in the no extensive margin case and $\frac{1}{\epsilon}$ with an extensive margin. As constant local welfare elasticities are effectively global elasticities, global welfare gains can be computed as the area of the rectangle between any two values of λ_{jj} . For our hypothetical HLOY

⁶ A partial trade elasticity is one that reflects both intensive margin ($\sigma - 1$) and extensive margin responses to a change in trade costs but holds the relative wage and price index fixed; this is precisely the elasticity that is estimated in gravity equations with location and destination fixed effects. [Bas et al. \(2017\)](#) propose an alternative to gravity estimation for this parameter based on micro-data leveraging the link between the hazard function and the mean-to-min ratio of sales in each market.

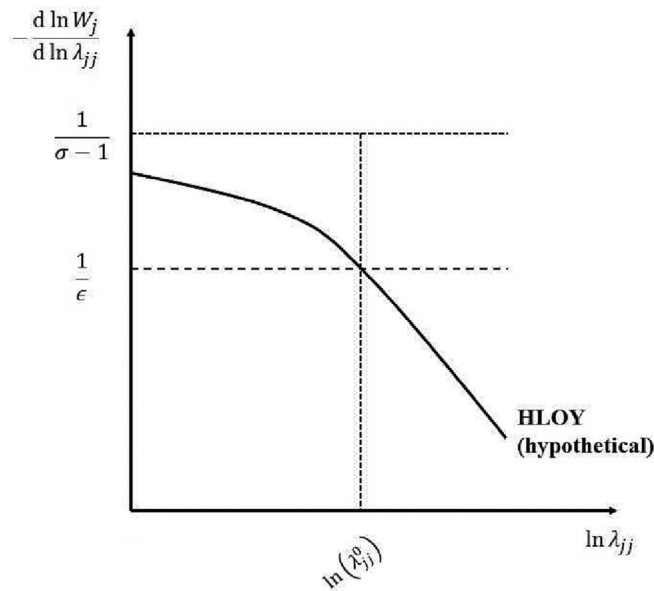


Fig. 2. Variation in elasticities and welfare.

Note: Figure plots the elasticity of welfare with respect to the domestic expenditure share for cases where this elasticity is constant (e.g. Armington with $1/(\sigma - 1)$) and Melitz-Pareto with $1/\epsilon$) and for a hypothetical economy that satisfies the HLOY conditions but does not feature isoelastic import demand.

economy, the local elasticity of welfare is identical to $\frac{1}{\epsilon}$ in the vicinity of $\ln \lambda_{jj}^0$, implying that our formula and ACR deliver identical local welfare gains because $\frac{1}{\sigma - 1} - \frac{1}{\epsilon} = \frac{1}{\sigma - 1} \frac{d \ln \frac{x_{jj}^0}{x_{jj}^0}}{d \ln \lambda_{jj}^0}$. However, welfare gains calculated using the ACR formula will be biased down (up) when evaluating global welfare changes with domestic expenditures below (above) λ_{jj}^0 .

To recap, the ACR formula, given that it does not need data on continuing/exiting varieties, is likely to be useful when either (a) there are small changes in λ_{jj} and the local import elasticity is known or (b) there are large (or hypothetically large, e.g. autarky) changes in λ_{jj} and we are confident that import demand is isoelastic with a known elasticity. However, when $\frac{x_{jj}^0}{x_{jj}^0}$ is observed and there is confidence in the estimate of σ , our formula works for global changes in λ_{jj} under weaker assumptions and could imply welfare gains below or above those implied by the ACR formula for particular values of ϵ and σ (as depicted in Fig. 2).

3. Application to the Canada-US Free Trade Agreement

3.1. Data

The Canada-US Free Trade Agreement (CUSFTA) was signed on January 2, 1988 and mandated the elimination of bilateral import tariffs in manufacturing, phased-in over a ten-year period starting on January 1, 1989. By 1996, Canadian tariffs on US imports had fallen from an average of 8% (equivalent to a 16% effective tariff rate) to about 1%. US tariffs on Canadian imports fell from about 4% in 1988 to below 1% during this period. Bilateral manufacturing trade almost doubled during this period and the agreement represents a large shock for Canada's manufacturing sector as about 70% of its trade is conducted with the US. Given the size of the CUSFTA shock, this period is likely to be informative about the size and nature of domestic and foreign extensive margin effects induced by trade liberalization and the consequent welfare gain.

To implement our formula we need information on domestic sales of continuing firms in Canada before and after CUSFTA came into force. We use the micro-data from Canada's Annual Survey of Manufacturing Establishments, so what we call "firms" going forward are really manufacturing plants and we are less concerned with how mergers might affect our estimates of exit.⁸ This survey covers all but the very smallest Canadian manufacturing establishments with sales below \$30,000 Canadian dollars. Our analysis focuses on the 1978–1988 and 1988–1996 time periods. We consider 1978–1988 as the "pre-CUSFTA" period and 1988–1996 as the "post-CUSFTA" period.⁹ The information we use from these data include establishment id, exports, and sales. In each of the two time periods, we use the establishment id to identify firms as entrants, exiters, and continuing firms.

⁷ Note that even when demand is not isoelastic, there is some "average" ϵ between any two given values of λ_{jj} that could be plugged into the ACR formula such that it would deliver the same unbiased estimate of welfare gains as our formula. However, the appropriate value of ϵ would be different for each scenario and may not correspond to an estimate from a gravity equation. One would instead have to rely on either parametric assumptions about productivity (as in Melitz and Redding (2015), Head et al. (2014), and Fernandes et al. (2022)) or non-parametric estimation (as in Adao et al. (2020)).

⁸ This survey was initially called the Census of Manufactures and is now known as Annual Survey of Manufactures.

⁹ We also chose these time periods because Statistics Canada officials indicated to us that the years with the best sampling frame are 1978, 1988, and 1996.

Table 1
Revenue shares of Canadian firms and implied welfare changes.

	1978–1988	1988–1996	Difference
$\Delta \ln X_{ij}^c / X_{ij}^c$ ¹	2.97%	12.03%	9.06%
$\Delta \ln \lambda_{ij}$ ²	0.69%	−25.91%	−26.61%
$\Delta \ln \lambda_{ij}^c$ ³	3.66%	−13.88%	−17.55%
HLOY Welfare Gains $\sigma = 3.72$	−1.35%	5.10%	6.45%
ACR Welfare Gains $\epsilon = 4.71$	−0.15%	5.50%	5.65%

Note: Column 1 (1978–1988) imputes the share or changes over 8 years based on the change over 10 years. Calculated from micro-data of Canada's Annual Survey of Manufacturing. See text for details.

¹ Change in domestic revenues of *continuing* Canadian firms/all Canadian firms.

² Change in total domestic sales of *all* Canadian firms/total sales in Canadian market using US export data.

³ Change in total domestic revenues of *continuing* Canadian firms/total sales in Canadian market.

We define an *entrant* as an establishment not in the data at the *beginning* of the time period, an *exiter* as an establishment not in the data at the *end* of the time period, and a *continuing* establishment as one that was present in the data at the beginning and at the end of a time period.

We supplement these data on domestic sales by Canadian manufacturing establishments with data on US manufacturing exports to Canada, which allow us to construct λ_{ij}^c . In Appendix Table C1 we also report results that assume manufacturing imports are equal to Canadian manufacturing exports (measured using the same Canadian establishment data mentioned above). The results are quite similar which suggests that while neither balanced trade nor exclusive trade with the US hold exactly in the data, they are reasonable approximations.¹⁰ Note that our analysis uses data for the manufacturing sector and ignores non-manufacturing trade both because this was excluded from CUSFTA liberalization and because panel establishment data are not available for raw material industries.¹¹

3.2. Application to Canada's welfare gains during CUSFTA period

We now apply our sufficient statistic (1) to measure Canadian welfare gains with a flexible extensive margin during the 1988–1996 post-CUSFTA period. The key parameter is the elasticity of substitution across varieties σ . Based on several empirical estimates, we pick $\sigma = 3.72$ as our baseline.¹² We also present data on the pre-CUSFTA period (1978–1988) and the differenced data for comparison, as these may be informative about trends or firm dynamics in Canada given that the earlier period did not feature major trade shocks.¹³ Given the size of the CUSFTA shock we view this simple before-after analysis as informative about the welfare effects of CUSFTA, but will also present results comparing more and less liberalized industries that are similar to the industry difference-in-difference approach to identifying causal effects of trade liberalization.

Table 1 presents the key data moments that inform our welfare statistic and their magnitudes during the pre- and post-CUSFTA periods. Row 1 in Table 1 shows the change in the share of continuing domestic firms as a share of all domestic firms. This increased from 2.97% before CUSFTA (1978–1988) to 12.03% after CUSFTA (1988–1996). Eq. (1) says that the key statistic is the change in domestic sales of continuing domestic firms as a share of *total* sales in the domestic market. This is simply the sum of the change in sales of continuing domestic firms as a share of all domestic firms shown in row 1 and the share of domestic firms in total sales. The latter, shown in Row 2, indicates that the market share of domestic firms fell massively – almost 26% – in the eight years after CUSFTA went into effect. This decrease is particularly notable relative to the very small (0.69%) increase in the market share of domestic firms in the period prior to CUSFTA. The last row in Table 1 shows $\Delta \ln \lambda_{ij}^c$ as the sum of rows 1 and 2. The share of continuing domestic firms in total sales in the Canadian market fell by 13.88% in 1988–1996, which can be compared to an increase of 3.66% in the period prior to CUSFTA.

The next to last row presents estimates of our welfare statistic using our baseline value of $\sigma = 3.72$ in Table B1. For comparison, the last row shows the ACR welfare statistic, where we assume $\epsilon = 4.71$.¹⁴ In column 2 we report the welfare gains during the post-CUSFTA period, which are 5.10% using our statistic and 5.50% using the ACR statistic. In column 3 we report the difference between welfare gains during the post-CUSFTA period and the pre-CUSFTA period, based on the idea that this may control for pre-existing trends in import and domestic exit dynamics. The magnitude of welfare gains are only slightly larger given the limited changes in λ_{ij}^c and λ_{ij} during the pre-period, but now the ACR statistic is slightly lower (5.65%) than our statistic (6.45%).

In online Appendix A, we show how our welfare formula can be extended to the existence of non-tradables as well as intermediate goods. To implement this, we only need data on the expenditure share on manufacturing and the intermediate input share. Canada's manufacturing expenditure share during this period was about 0.32 and the share of value added in gross

¹⁰ Canada had a trade surplus with the US during this period but it was fairly stable. The ratio of Canadian goods exports to the US over goods imports from the US rose from 1.14 to 1.16 between 1988 and 1996, see <https://www.census.gov/foreign-trade/balance/c1220.html#1988>.

¹¹ Raw materials (based on the WITS classification) made up 15.4% of Canada's imports and 8.5% of its exports in 1989, declining to 12.7% and 8.0% respectively by 1996, so excluding these has only minor effects on welfare gains.

¹² See Appendix B for more details.

¹³ As the pre-period is 10 years and the CUSFTA period is 8 years, we multiply pre-period changes by 8/10 to make them more comparable.

¹⁴ See Appendix B for a discussion of the empirical studies behind our choice of the baseline value of ϵ .

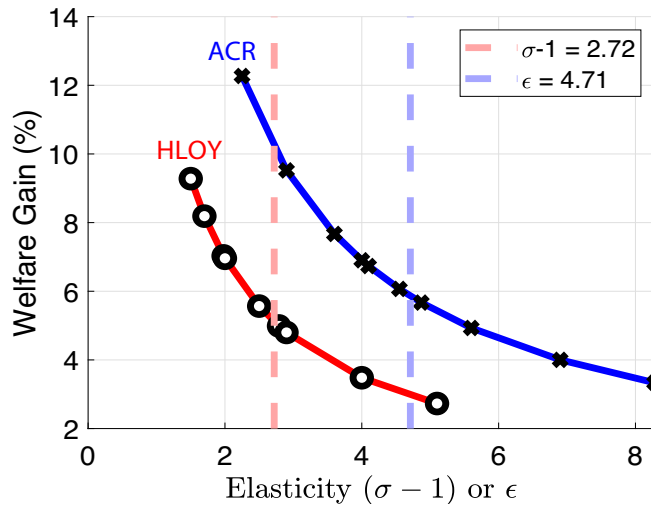


Fig. 3. Welfare gains from CUSFTA.

Note: Figure shows welfare change estimates for the cumulative 8-year period after CUSFTA, relative to the 8-years before CUSFTA. Estimates based on our sufficient statistic are displayed in red with circle markers and estimates from the ACR are displayed in blue with a cross as marker. The x-axis measures the elasticity used, which is $\sigma - 1$ for our welfare statistic and ϵ for ACR. See text for details. Each marker is the value of the sufficient welfare statistics with an elasticity from a different empirical study. The list of empirical studies used for these elasticities can be found in Appendix Tables B1 for σ and Table B2 for ϵ .

production was about 0.5, which suggests that the overall welfare gains are only 64% as large as this ($0.32/0.5 = 0.64$) using both of the adjustments discussed earlier but about twice as large for the manufacturing sector in isolation. Also note that the negative welfare value reported for the pre-period only implies negative welfare for the HLOY statistic under the assumption that there is no increase in the domestic real wage in terms of the output of continuing domestic firms; in reality this could be changing for reasons related and unrelated to CUSFTA, an issue we revisit in the next section.

Overall, the welfare gains are remarkably similar using either formula for the elasticity estimates we used, but of course the deviation between the welfare changes implied by the formulas depends importantly on the elasticities used. In Fig. 3 we plot the welfare gains based on the HLOY and ACR statistics for different values of $\sigma - 1$ and ϵ . As can be seen, welfare gains are quite similar for either statistic when using the central elasticity estimates from the literature but could be quite different depending on one's preferred elasticity. In particular, elasticities chosen to match the firm size/productivity distribution under Zipf's law (which implies $\epsilon/(\sigma - 1)$ close to 1 and hence $\epsilon \approx \sigma - 1$) would imply a substantially larger upward bias of the ACR statistic relative to the HLOY statistic given the size of the $\Delta \ln X_{ij}^c/X_{ij}$ term in our data.¹⁵ However, moments of the firm size distribution that do not account for substantial overlap in the size/productivity distributions of exporters and non-exporters seem unlikely to be informative about the magnitude of firm selection effects under a trade shock; an advantage of our statistic in this respect is that it uses a data moment ($\Delta \ln X_{ij}^c/X_{ij}$) that accounts for arbitrary patterns of firm entry and exit.

3.3. Welfare changes from continuing domestic firms

So far we computed welfare gains during the post-CUSFTA period using changes in the revenue share of domestic continuing establishments, which provides a valid measure of overall welfare gains holding the value of these establishments (i.e. the real wage of workers defined in terms of their output) constant. While the original Melitz model and the models analyzed in Arkolakis et al. (2012) have this feature, there are two distinct reasons why there could be welfare changes related to within-firm effects. First, models with exogenous firm productivity could still feature changes in domestic markups or product variety/quality for these firms. Second, endogenous firm productivity could also change the real wage of workers defined in terms of the output of continuing firms.

While our formula in eq. (1) already accounts for these issues when it comes to continuing foreign firms, they are difficult to address directly for the continuing domestic firms without more detailed data on individual products and prices to measure \tilde{p}_{ij}^c (or $\tilde{\varphi}_{ij}^c$ when only within-firm productivity is allowed to vary). We can partly address this by noting that our formula can capture welfare gains associated with changes in the value to consumers of some continuing domestic establishments, provided one specifies a restricted set of continuing domestic establishments that have a constant real wage defined in terms of their output. By recalculating eq. (1) using the domestic revenue share of this restricted set, any increase in the value of the other continuing domestic establishments will be captured by the formula. Intuitively, if we observe a larger fall in λ_{ij}^c for the restricted set of continuing firms than the full set of continuing firms, the increase in relative domestic revenues for the other continuing firms captures any additional

¹⁵ Di Giovanni and Levchenko (2013) make a related point in the context of comparing welfare gains from an Armington model versus a Melitz-Pareto model with an extensive margin and Zipf's law.

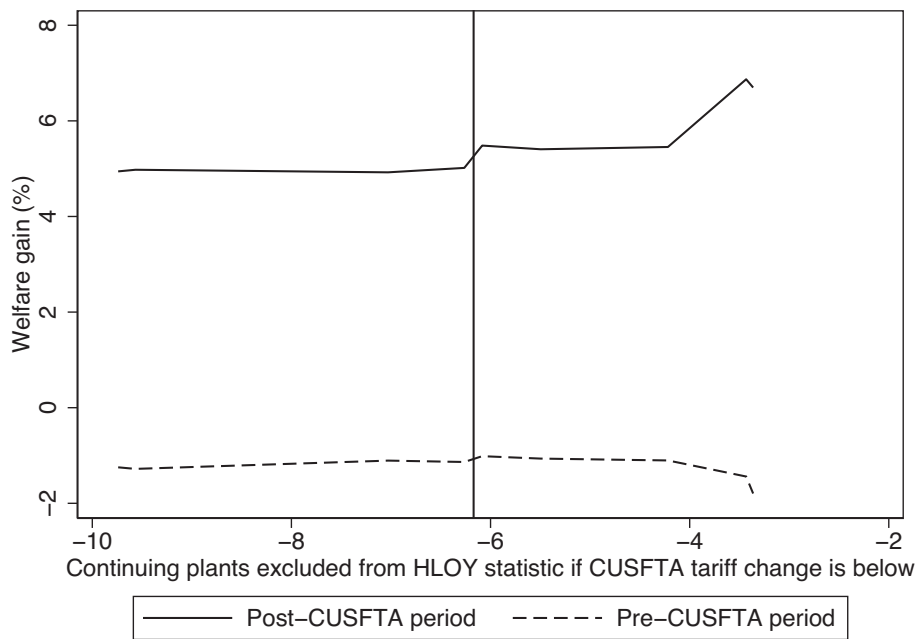


Fig. 4. Welfare gains including (some) within-plant gains.

Note: Figure shows welfare change estimates for the cumulative 8-year period after CUSFTA (solid line) and 10-year period before CUSFTA (dashed line, converted to 8-year basis). Estimates are based on our sufficient statistic with $\sigma = 3.72$ but with different restrictions on the set of continuing firms. From left to right, we shrink the set of continuing firms to only include those firms in industries with tariff cuts smaller than the number on the x-axis (percentage point tariff reductions). Vertical line represents the CUSFTA import tariff cut for the median 2-digit Canadian industry.

welfare effects from changes in their productivity, markups, quality, or product variety relative to the restricted set of continuing firms.

In our setting, a natural way to specify this restriction is to use only domestic continuing establishments in sectors that had low initial tariffs in 1988 (and hence minimal tariff reductions due to CUSFTA). Fig. 4 presents results from an analysis along these lines. When we split our 22 two-digit industries by above and below median import tariff cuts (represented by the vertical line) and define our continuing firm share using only continuing firms in industries where tariff cuts were below the median tariff cut, we find that welfare gains in the post-CUSFTA period are slightly larger but close to our estimates reported in Table 1. The gains get slightly larger moving to the right as we further restrict continuing firms to the industries with only the smallest tariff cuts, and slightly smaller as we expand the set of continuing firms to include industries with all but the largest tariff cuts. When all continuing domestic firms are included welfare gains converge to our estimate in Table 1. Overall, this analysis suggests that the magnitude of within-domestic firm welfare gains attributable to CUSFTA tariff cuts – the additional welfare gains over this period above and beyond those identified in Table 1 – are plausibly in the range of 0–2% when focusing on the post-CUSFTA period and 0–3% when accounting for pre-CUSFTA trends.

Note that in principle this approach could be extended along dimensions other than the size of industry tariff cuts. For example, if one believed that the productivity of exporting firms rises due to trade liberalization, one could restrict the sample to continuing establishments that do not export, thereby capturing any additional welfare gains arising from an increase in the value of continuing exporting firms relative to continuing non-exporters. If there is a specific set of continuing establishments for which changes in the relevant factors – markups, productivity, product variety, quality – could be measured directly, this would be a natural choice for the restricted set of establishments. The only caveat is that, as mentioned in section 2.2.1, looking at changes in the revenue share for too small of a set of firms is likely to confound the aggregate effects of trade liberalization on prices and variety that our statistic is aimed at capturing with idiosyncratic firm-level shocks to productivity and demand.

Our results here can be compared to several estimates of changes in within-firm productivity during this period. An important caveat is that changes in the value of continuing domestic firms in terms of domestic wages may be distinct from typical measures of firm productivity in the literature. Firm productivity is often measured using revenue or value added per worker but in a canonical Melitz model revenue and value added per worker are equalized across firms in equilibrium. These measures also potentially confound export participation effects (e.g. a firm can increase its value added per worker by selling higher prices or quantity abroad) with increases in the value of the firm to domestic consumers. Deflating by an aggregate or industry-level output price index may also fail to resolve this issue depending on the type of adjustments that are accounted for by statistical authorities. Beyond productivity, changes in within-firm domestic markups, product variety, and product quality may or may not be adequately captured by these real revenue per worker or value added per worker measures.

With these caveats, our data can be used to directly estimate changes in revenue or value added per worker during the 1978–1988 and 1988–1996 periods for continuing domestic firms. We deflate these changes using the July Industrial Product Price

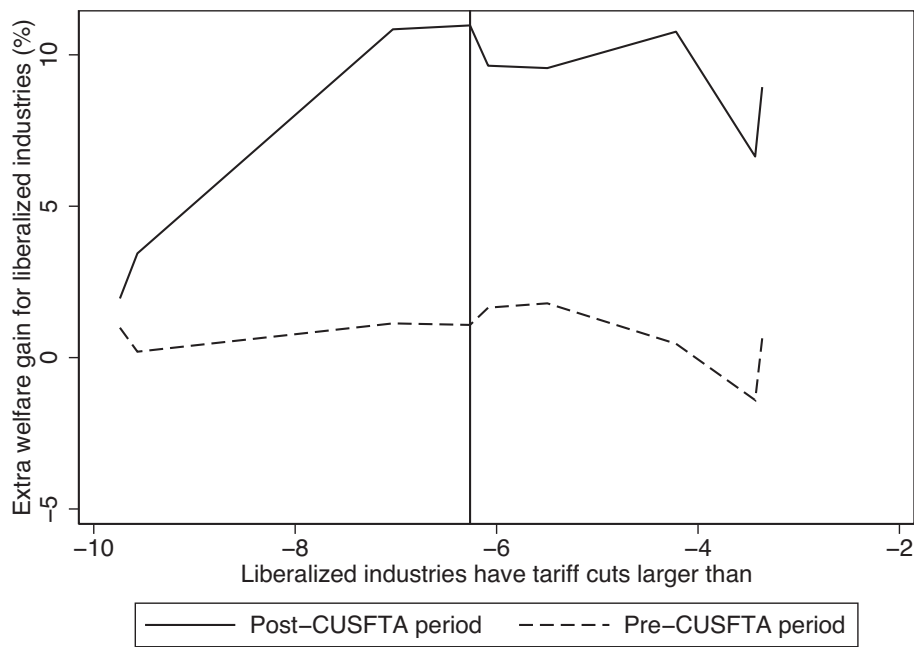


Fig. 5. Extra welfare gains for liberalized industries.

Note: Figure shows the difference in welfare gains for liberalized industries versus others for the cumulative 8-year period after CUSFTA (solid line) and 10-year period before CUSFTA (dashed line, converted to 8-year basis). Estimates are based on our sufficient statistic with $\sigma = 3.72$ but with different thresholds for defining “liberalized” industries. From left to right, we add industries with smaller tariff cuts to the group of “liberalized” industries (and remove them from the control group). The vertical line represents the CUSFTA import tariff cut for the median 2-digit Canadian industry.

Index (which measures producer prices in Canada). Converted to a similar 8 year basis, real revenue per worker rose 12.0% in the pre-CUSFTA period versus 15.4% in the post-CUSFTA period, while real value added per worker rose 14.7% in the pre-CUSFTA period and 13.6% in the post-CUSFTA period. These changes are similar in magnitude to those calculated by Lileeva (2008) for the set of firms common to 1980 and 1996 using 4-digit industry price deflators; Lileeva finds a 14.5% increase in real value added per worker during the pre-CUSFTA period and 10.8% increase during the post-CUSFTA period. Changes in real value added per worker imply some deceleration in continuing firm productivity growth during the CUSFTA period, while changes in revenue per worker are more consistent with an acceleration of productivity growth. Lileeva (2008) and Melitz and Trefler (2012) use cross-sectional variation in tariff cuts across industries and firms to provide a causal measure of changes in within-firm productivity due to CUSFTA tariff cuts. Both papers conclude that most of the growth in within-firm productivity is driven by continuing and new Canadian exporters, with the increase caused by CUSFTA tariff cuts ranging between 4% and 5.4%. Altogether, these studies and our own analysis suggest that within-firm productivity growth could be about as important as the other sources of gains from trade during this period.

3.4. Were these welfare gains caused by CUSFTA tariff cuts?

Our statistic measures welfare gains from changes in the set of domestic and foreign varieties and changes in the prices of foreign varieties, relative to continuing domestic varieties. We applied our statistic to the post-CUSFTA period and found large welfare gains during this period, substantially larger than during the pre-CUSFTA period. However, we acknowledge that other shocks, both domestic and foreign, could have driven the changes in our statistic, particularly if they varied substantially between the pre- and post-CUSFTA period. One way we can assess the extent to which movements in our statistic are being driven by tariff cuts under CUSFTA is to compare changes for more and less liberalized industries, in the spirit of Trefler (2004) and other papers, with less liberalized industries serving as a “control” group or counter-factual.

We explore this in Fig. 5, where we plot the difference in welfare gains for liberalized (high tariff cut) industries versus control (low tariff cut) industries for the post-CUSFTA and pre-CUSFTA period using our welfare statistic.¹⁶ The vertical line coincides with splitting the 2-digit industries based on the median tariff cuts, and moving from left to right we add industries with smaller tariff cuts to the liberalized group and remove them from the control group. The graph reveals two key points. First, our welfare statistic does not display any notable pre-trends when comparing industries with larger and smaller tariff cuts under CUSFTA.

¹⁶ For this exercise we remove the auto industry (Canadian SIC 32) from the sample as it is difficult to quantify the relevant tariff cut. Under the Autopact agreement that existed for decades prior to CUSFTA, Detroit automakers received tariff free access to the Canadian market subject to local content requirements. CUSFTA expanded this tariff-free access to non-Detroit automakers subject to similar local content requirements, representing a large tariff cut for many European and Asian automakers producing in the United States but a zero tariff cut for Detroit automakers.

Second, industries with higher tariff cuts have substantially higher welfare gains than those with lower tariff cuts, suggesting that most of the changes in welfare we measure with our statistic during the post-CUSFTA period are in fact driven by the CUSFTA tariff cuts themselves rather than other foreign shocks or macroeconomic forces that would have similar effects on industries with high versus low tariff cuts.

4. Conclusion

We propose a new sufficient statistic to measure ex-post welfare gains in trade models for which the import demand system is not necessarily isoelastic. This includes a Ricardian model of trade with an arbitrary distribution of productivity and a Melitz model with any pattern of selection into exporting and production as well as any distribution of productivity. The statistic is simple to calculate, as it is just a function of one data moment, the market share of continuing domestic firms, and one parameter, the elasticity of substitution across varieties. When applied to the CUSFTA liberalization period, our statistic indicates an approximately 5.1% increase in Canadian welfare due to the combination of net domestic exit, net foreign entry and cheaper foreign varieties. These gains are only slightly lower than those implied using the ACR statistic when both statistics are implemented using typical elasticity estimates from the literature, which suggests that despite substantial deviations between a textbook Melitz-Pareto model and the firm selection resulting from a large intra-industry trade shock, the bias from applying the ACR statistic can be small for reasonable parameter values.

While our proposed statistic provides a more robust way to measure welfare gains in trade models with an extensive margin, there are at least three limitations. First, it does not measure the potential effect of trade liberalization on productivity growth among incumbent domestic firms, except when applied to a restricted set of firms that can be viewed as largely exempt from trade liberalization. Second, the statistic by itself does not tell us what fraction of the implied welfare change is due to changes in trade costs. These limitations are common to other approaches that have been proposed in the literature and highlight the challenge of applying statistics derived from models assuming fixed productivity distributions and well-identified trade cost comparative statics to real world data from trade liberalization episodes. However, we find some support for a causal interpretation based on a comparison of more to less liberalized industries. A third limitation of our statistic is that it can only be applied to measure ex-post welfare gains, and cannot tell us the gains from counter-factual changes in trade costs such as a hypothetical liberalization scenario or a hypothetical return to autarky. This is because our approach leverages data on observed entry and exit, rather than predicting extensive margin changes using stronger assumptions about the distribution of firm productivity and nature of selection or more detailed modeling that could allow for extrapolation outside of observed firm selection.

Data availability

Replication data and code for Hsieh, Li, Ossa and Yang "Gains from Trade Liberalization with Flexible Extensive Margin Adjustment" (Original data) (Mendeley Data)

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jinteco.2023.103756>.

References

- Adao, R., Arkolakis, C., Ganapati, S., 2020. Aggregate Implications of Firm Heterogeneity: A Nonparametric Analysis of Monopolistic Competition Trade Models. NBER Working Paper 28081.
- Arkolakis, C., Costinot, A., Rodriguez-Clare, A., 2009. New Trade Models, Same Old Gains? NBER Working Paper 15628.
- Arkolakis, C., Costinot, A., Rodriguez-Clare, A., 2012. New trade models, same old gains? *Am. Econ. Rev.* 102 (1), 94–130.
- Armerter, R., Koren, M., 2015. Economies of scale and the size of exporters. *J. Eur. Econ. Assoc.* 13 (3), 482–511.
- Bas, M., Mayer, T., Thoenig, M., 2017. From micro to macro: demand, supply and heterogeneity in the trade elasticity. *J. Int. Econ.* 108, 1–19.
- Broda, C., Weinstein, D., 2006. Globalization and the gains from variety. *Q. J. Econ.* 121 (2), 541–585.
- Di Giovanni, J., Levchenko, A., 2013. Firm entry, trade and welfare in Zipf's world. *J. Int. Econ.* 89 (2), 283–296.
- Eaton, J., Kortum, S., 2002. Technology, geography and trade. *Econometrica* 70 (5), 1741–1779.
- Eaton, J., Kortum, S., Kramarz, F., 2011. An anatomy of international trade: evidence from French firms. *Econometrica* 79 (5), 1453–1498.
- Feenstra, R., 1994. New product varieties and the measurement of international prices. *Am. Econ. Rev.* 84 (1), 157–177.
- Fernandes, A., Klenow, P., Meleshchuk, S., Pierola, M., Rodriguez-Clare, A., 2022. The intensive margin of trade: how big and how important? *Am. Econ. J. Macro.* <https://www.aeaweb.org/articles?id=10.1257/mac.20200269&&from=f> in press.
- Head, K., Mayer, T., Thoenig, M., 2014. Welfare and trade without pareto. *Am. Econ. Rev. Pap. Proc.* 104 (5), 310–316.
- Hsieh, C.-T., Li, N., Ossa, R., Yang, M.-J., 2020. Accounting for the new gains from trade liberalization. *J. Int. Econ.* 127.
- Krugman, P., 1980. Scale economies, product differentiation and the pattern of trade. *Am. Econ. Rev.* 70 (5), 950–959.
- Lileeva, A., 2008. Trade evidence and productivity dynamics: evidence from Canada. *Can. J. Econ.* 41 (2), 360–390.
- Melitz, M., 2003. The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica* 71 (6), 1695–1725.
- Melitz, M., Redding, S., 2015. New trade models, New welfare implications. *Am. Econ. Rev.* 165 (3), 1105–1146.

- Melitz, M., Trefler, D., 2012. Gains from trade when firms matter. *J. Econ. Perspect.* 26 (2), 91–118.
- Pavcnik, N., 2002. Trade liberalization, exit, and productivity improvements: evidence from Chilean plants. *Review of Economic Studies* 69 (1), 245–276.
- Trefler, D., 2004. The long and short of the Canada-US free trade agreement. *Am. Econ. Rev.* 94 (4), 870–895.

Further-reading

- Bernard, A., Eaton, J., Jensen, J., Kortum, S., 2003. Plants and productivity in international trade. *Am. Econ. Rev.* 93, 1268–1290.
- Berthou, A., Fotagne, L., 2015. Variable trade costs, composition effects and the intensive margin of trade. *World Econ.* 39 (1), 54–71.
- Boehm, C., Levchenko, A., Pandalai-Nayar., 2021. The Long and Short (Run) of Trade Elasticities. NBER Working Paper.
- Buono, I., Lalanne, G., 2012. The effect of the Uruguay round on the intensive and extensive margin of trade. *J. Int. Econ.* 86, 269–283.
- Caliendo, L., Parro, F., 2015. Estimates of the trade and welfare effects of NAFTA. *Rev. Econ. Stud.* 82 (1), 1–4.
- Fitzgerald, D., Haller, S., 2018. Exporters and shocks. *J. Int. Econ.* 113, 154–171.
- Fontagne, L., Martin, P., Orefice, G., 2018. The international elasticity puzzle is worse than you think. *J. Int. Econ.* 115, 115–129.
- Head, K., Ries, J., 2001. Increasing returns versus national product differentiation as an explanation for the pattern of U.S.-Canada trade. *Am. Econ. Rev.* 91 (4), 858–876.
- Hottman, C., Redding, S., Weinstein, D., 2016. Quantifying the sources of firm heterogeneity. *Q. J. Econ.* 131 (3), 1296–1364.
- Imbs, J., Mejean, I., 2015. Elasticity optimism. *Am. Econ. J. Macroecon.* 7 (3), 43–83.
- Oberfeld, E., Raval, D., 2021. Micro data and macro technology. *Econometrica* 89 (2), 703–732.
- Simonovska, I., Waugh, M., 2014. The elasticity of trade: estimates and evidence. *J. Int. Econ.* 92 (1), 34–50.