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Chang-Tai Hsieh
Nicholas Li
Ralph Ossa
Mu-Jeung Yang

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ABSTRACT

We measure the "new" gains from trade reaped by Canada as a result of the Canada-US Free Trade Agreement (CUSFTA). We think of the "new" gains from trade of a country as all welfare effects pertaining to changes in the set of firms serving that country as emphasized in the so-called "new" trade literature. To this end, we first develop an exact decomposition of the gains from trade which separates "traditional" and "new" gains. We then apply this decomposition using Canadian and US micro data and find that the "new" welfare effects of CUSFTA on Canada were negative.

Chang-Tai Hsieh
Booth School of Business
University of Chicago
5807 S Woodlawn Ave
Chicago, IL 60637
and NBER
chsieh@chicagoBooth.edu

Nicholas Li
University of Toronto
150 St. George Street
Toronto, ON M5S 3G7
Canada
nick.li@utoronto.ca

Ralph Ossa
University of Chicago
Booth School of Business
5807 South Woodlawn Avenue
Chicago, IL 60637
and NBER
ralph.ossa@chicagobooth.edu

Mu-Jeung Yang
Department of Economics
University of Washington
Savery Hall, 327
Seattle, WA 98195-3330
mjyang@uw.edu

1 Introduction

Among the most celebrated contributions of the so-called "new" trade theory is that it also suggests "new" gains from trade. In particular, the Krugman (1980) model predicts that trade liberalization expands import variety which was absent from earlier comparative advantage models of trade. Moreover, the Melitz (2003) model adds that it can also increase domestic productivity by inducing a reallocation of resources from less to more productive firms. Together, these two forces are widely believed to account for a substantial fraction of the overall gains from trade, not least because their practical relevance is also documented by a large empirical literature.[1]

In this paper, we go back to first principles and re-examine the importance of these "new" gains from trade. In particular, we first derive an exact decomposition of the gains from trade into "traditional" gains and "new" gains, where the "new" gains comprise variety and productivity effects. We then apply our decomposition to measure the "new" gains from trade reaped by Canada as a result of the Canada-US Free Trade Agreement (CUSFTA). Our decomposition is based on a generalized Melitz (2003) model which remains agnostic about the determinants of entry into production and exporting and also makes no assumptions on the distribution of firm productivities.[2]

Our decomposition allows us to make a number of elementary points about the mechanics of the "new" gains from trade. A first point is that import variety gains can be overturned by domestic variety losses resulting in an ambiguous overall effect on the gains from trade. A second point is that entry is always welfare increasing and exit is always welfare reducing with the associated productivity effects only playing a modulating role. A corollary of this is that the increase in domestic productivity brought about by the exit of the least productive firms is actually indicative of a welfare loss contrary to what is commonly argued in the heterogeneous

[1] For example, Broda and Weinstein (2006) document that the number of varieties imported into the US market tripled between 1972 and 2001. Also, Pavcnik (2002) estimates that Chile's manufacturing productivity increased by 19 percent following its trade liberalization in the late 1970s and early 1980s, two-thirds of which was due to resource reallocations from less to more productive firms. These are just two of many possible examples and we provide a more detailed overview below.

[2] The Melitz (2003) model is an extension of the Krugman (1980) model and therefore captures both variety gains and productivity gains. In fact, it even captures variety gains more naturally than the Krugman (1980) model since the total number of varieties available to consumers is actually constant in Krugman (1980) unless infinite trade costs drive the economy to complete autarky.

firm literature.

For example, CUSFTA allows some additional US firms to enter into exporting which brings about import variety gains. However, these import variety gains are attenuated because new exporters tend to be less productive than continuing exporters implying an import productivity loss. On the other hand, CUSFTA forces some Canadian firms to exit out of production which leads to domestic variety losses. But these variety losses are again dampened because exiting firms tend to be less productive than continuing firms resulting in a domestic productivity gain. Overall, the import variety gains would have to dominate the domestic variety losses for there to be positive "new" gains from trade.

Our decomposition is in terms of simple sufficient statistics which are easily measurable using micro data. The key statistic is the change in the market share of continuing firms, defined as all firms which continue to serve a particular market over a given time period. This statistic captures the overall welfare effects of entry and exit taking into account firm productivities. For example, if the domestic market share of continuing Canadian firms rises following CUSFTA, this indicates that exit was more important than entry, either because more firms exited than entered or because the exiting firms were more productive than the entering firms.

We measure the "new" gains from CUSFTA on the Canadian economy in simple differences and differences-in-differences using aggregate and industry-level data. Our main result is that Canada actually suffered from "new" welfare losses following CUSFTA even though they were dominated by larger "traditional" welfare gains. For example, our differences-in-differences specification which exploits cross-industry variation in Canadian tariff cuts suggests that Canada's real income fell by -0.22% per year as a result of domestic exit out of production and rose by 0.03% per year as a result of US entry into exporting resulting in an overall real income loss of -0.19% per year.

We believe that our analysis makes two main contributions. First, we provide a novel decomposition of the gains from trade in a general heterogeneous firm environment which can be implemented using simple sufficient statistics. Second, we make the first comprehensive attempt to directly measure the "new" gains from trade using micro data taking into account the effects of trade liberalization on domestic as well as foreign firms. Earlier studies estimating variety and productivity effects typically only focus on the number of imported varieties or the average productivity of domestic firms thereby providing only an incomplete assessment of the "new" gains from trade.[3]

We make these contributions building on earlier advances in the measurement of the "new" gains from trade. Our paper is most closely related to Feenstra (1994) and our decomposition of the "new" gains from trade can be roughly thought of as a decomposition of the "Feenstra-Ratio" which is widely used to adjust changes in ideal price indices for new product varieties. Feenstra (2010) himself has also used his method to analyze the gains from trade in a Melitz (2003) model with Pareto distributed productivities showing that the aggregate productivity gains can also be interpreted as a gain in product variety but now on the export side of the economy.

Our paper also directly relates to Trefler's (2004) analysis of the effects of CUSFTA on the Canadian economy. While Trefler (2004) is primarily interested in measuring the domestic productivity and employment effects of CUSFTA, our focus lies on identifying the associated "new" gains from trade which involves combining micro data for Canadian firms with additional micro data on US exporters. In addition, our measurement of the productivity effects of CUSFTA also differs from Trefler's (2004) in fundamental ways. As will become clear later, we adopt firm revenue as a sized-based measure of firm productivity and compute all selection effects in a model consistent way.[4]

We ask a different question than the recent Arkolakis et al (2012) gains from trade literature.[5] In particular, we are less interested in a quantification of the overall gains from trade but more in a decomposition of the gains from trade with a particular focus on exactly identifying the "new" gains from trade. As a result, we are also not attempting to compare the gains from trade across models but instead develop a decomposition taking as given one model, specifically a generalized version of Melitz (2003) which does not impose the restrictions on entry into production and exporting and the distribution of firm productivities used

[3] Prominent examples include the studies of Tybout et al (1991), Levinsohn (1993), Harrison (1994), Tybout and Westbrook (1995), Krishna and Mitra (1998), Pavcnik (2002), Trefler (2004), Broda and Weinstein (2006), and Topalova and Khandewal (2011).

[4] See also Head and Ries (1999), Breinlich (2008), Lileeva (2008), Lileeva and Trefler (2010), Melitz and Trefler (2012), and Breinlich and Cunat (forthcoming) for additional empirical analyses of CUSFTA.

[5] Other contributions to this literature include Arkolakis et al (2008), Atkeson and Burstein (2010), Melitz and Redding (2015), and Ossa (2015).

by Arkolakis et al (2012).[6]

Our point that import variety gains can be overturned by domestic variety losses is related to the observation of Baldwin and Forslid (2010) that the number of available varieties always falls in the Melitz (2003) model following trade liberalization if the importing country is sufficiently small. Our point that the productivity effects associated with entry and exit only ever have a modulating character and never overturn the underlying variety effects is related to the observation of Arkolakis et al (2008) that the gains from new import varieties are relatively small in the Melitz (2003) model because new exporters are less productive than continuing ones.

The remainder of this paper is organized as follows. In the next section, we present our methodology by developing our general heterogeneous firm model, describing our decomposition of welfare changes into "traditional" gains from trade and "new" gains from trade, and linking our decomposition to sufficient statistics that can be tabulated from micro data. In the third section, we then turn to our application to CUSFTA by discussing our data, describing our aggregate findings, and presenting our industry-level results which also include the results obtained from our differences-in-differences analysis. A final section then draws conclusions and summarizes our main results.

2 Methodology

2.1 Basic framework

Our methodology is based on a generic heterogeneous firm model of trade. Consumers have constant elasticity of substitution preferences over varieties sourced from many countries. In particular, the ideal price index in country j is given by $P_j = \left(\sum_{i=1}^{N} \int_{\omega \in \Omega_{ij}} p_{ij}(\omega)^{1-\sigma} d\omega\right)^{\frac{1}{1-\sigma}}$, where N is the number of countries, Ω_{ij} is the set of varieties produced in country i and consumed in country j, $p_{ij}(\omega)$ is the delivered price of variety ω produced in country i and consumed in country j, and $\sigma > 1$ is the elasticity of substitution. As a result, consumers have constant elasticity demands $q_{ij}(\omega) = \frac{p_{ij}(\omega)^{-\sigma}}{P_j^{1-\sigma}} Y_j$, where Y_j is total consumer expenditure

[6] Our paper is also related to the recent contribution of Caliendo et al (2015) which studies the effects of tariff reductions on entry in a quantitative version of Melitz (2003). Their main point is that tariff reductions increase entry by channeling more consumer expenditure to producers rather than government revenues.

in country j.

Firms are technologically heterogeneous and each firm has monopoly power over a single variety. Labor is the only factor of production and the marginal cost incurred by a firm from country i for producing and delivering one unit of output to country j is given by $\frac{w_i \tau_{ij}}{\varphi}$, where w_i is the wage rate in country i, τ_{ij} is an iceberg trade costs applying to shipments between country i and country j, and φ is the firm's productivity. Given the constant elasticity demands, this implies the pricing formula $p_{ij}(\varphi) = \frac{\sigma}{\sigma-1}\frac{w_i \tau_{ij}}{\varphi}$ since firms then charge a constant markup $\frac{\sigma}{\sigma-1}$ over marginal costs. We allow for M_{ij} firms to serve country i from country j but remain agnostic as to the specific entry process.

Many endogenous variables can now be expressed in terms of the productivity aggregates $\tilde{\varphi}_{ij} = \left(\int_{\varphi \in \Phi_{ij}} \varphi^{\sigma-1} dG_i(\varphi|\varphi \in \Phi_{ij})\right)^{\frac{1}{\sigma-1}}$, 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. In particular, the ideal price index can be rewritten as $P_j = \left(\sum_{i=1}^{N} M_{ij}\tilde{p}_{ij}^{1-\sigma}\right)^{\frac{1}{1-\sigma}}$ and the value of trade flowing from country i to country j can be expressed as $X_{ij} = M_{ij}\left(\frac{\tilde{p}_{ij}}{P_j}\right)^{1-\sigma} Y_j$, where $\tilde{p}_{ij} = \frac{\sigma}{\sigma-1}\frac{w_i \tau_{ij}}{\tilde{\varphi}_{ij}}$ is the price charged by the firm with productivity $\tilde{\varphi}_{ij}$. It can be shown that $\tilde{\varphi}_{ij}$ corresponds to a weighted harmonic mean of firm productivities so that we will simply refer to it as average productivity from now on.

2.2 Welfare decomposition

These results can be used to derive an exact decomposition of changes in the ideal price index. In particular, the above expression for trade flows implies that log changes in the price index can be decomposed as $\ln \frac{P_j'}{P_j} = \ln \frac{\tilde{p}_{ij}'}{\tilde{p}_{ij}} - \frac{1}{\sigma-1}\ln \frac{M_{ij}'}{M_{ij}} + \frac{1}{\sigma-1}\ln \frac{\lambda_{ij}'}{\lambda_{ij}}$, where apostrophes mark new values and $\lambda_{ij} = \frac{X_{ij}}{Y_j}$ are expenditure shares. Summing up over all source countries using the Sato (1976)-Vartia (1976) weights $\bar{\lambda}_{ij} = \left(\frac{\lambda_{ij}' - \lambda_{ij}}{\ln \lambda_{ij}' - \ln \lambda_{ij}}\right) / \left(\sum_{m=1}^{N} \frac{\lambda_{mj}' - \lambda_{mj}}{\ln \lambda_{mj}' - \ln \lambda_{mj}}\right)$, the last term cancels so that $\ln \frac{P_j'}{P_j} = \sum_{i=1}^{N} \bar{\lambda}_{ij}\left(\ln \frac{\tilde{p}_{ij}'}{\tilde{p}_{ij}} - \frac{1}{\sigma-1}\ln \frac{M_{ij}'}{M_{ij}}\right)$. This simply captures that changes in the price index are expenditure share weighted averages of changes in average prices and elasticity of substitution adjusted changes in available variety.

Our decomposition of welfare changes follows from this. We assume that total income is proportional to labor income so that per-capita welfare is proportional to real wages.[7] Then,

[7] Notice that this assumption holds trivially in the standard version of Melitz (2003) in which profits are

log changes in per-capita welfare can be written as $\ln \frac{W_j'}{W_j} = \sum_{i=1}^N \bar{\lambda}_{ij} \left(-\ln \frac{\tau_{ij}'}{\tau_{ij}} - \ln \frac{w_i'}{w_i} \right) + \sum_{i=1}^N \frac{\bar{\lambda}_{ij}}{\sigma-1} \ln \frac{M_{ij}'}{M_{ij}} + \sum_{i=1}^N \bar{\lambda}_{ij} \ln \frac{\tilde{\varphi}_{ij}'}{\tilde{\varphi}_{ij}}$ upon substituting $\tilde{p}_{ij} = \frac{\sigma}{\sigma-1} \frac{w_i \tau_{ij}}{\tilde{\varphi}_{ij}}$ and choosing w_j as the numeraire. To make explicit that $\tilde{\varphi}_{ij}$ can change because of changes in the average productivity of continuing firms or because of changes in the composition of firms, we separately define the average productivity of continuing firms $\tilde{\varphi}_{ij}^c$ and expand $\ln \frac{\tilde{\varphi}_{ij}'}{\tilde{\varphi}_{ij}} = \ln \frac{\tilde{\varphi}_{ij}^{c\prime}}{\tilde{\varphi}_{ij}^c} + \left(\ln \frac{\tilde{\varphi}_{ij}'}{\tilde{\varphi}_{ij}} - \ln \frac{\tilde{\varphi}_{ij}^{c\prime}}{\tilde{\varphi}_{ij}^c} \right)$. This then yields our exact decomposition of per-capita welfare changes,

$$\ln \frac{W_j'}{W_j} = \underbrace{\sum_{i=1}^N \bar{\lambda}_{ij} \left(-\ln \frac{\tau_{ij}'}{\tau_{ij}} - \ln \frac{w_i'}{w_i} + \ln \frac{\tilde{\varphi}_{ij}^{c\prime}}{\tilde{\varphi}_{ij}^c} \right)}_{\text{"traditional" gains from trade}} + \underbrace{\sum_{i=1}^N \bar{\lambda}_{ij} \left(\frac{1}{\sigma-1} \ln \frac{M_{ij}'}{M_{ij}} + \left(\ln \frac{\tilde{\varphi}_{ij}'}{\tilde{\varphi}_{ij}} - \ln \frac{\tilde{\varphi}_{ij}^{c\prime}}{\tilde{\varphi}_{ij}^c} \right) \right)}_{\text{"new" gains from trade}} \quad (1)$$

While this formula decomposes the welfare effects of arbitrary shocks, we use it to analyze the welfare effects of trade liberalization with the specific goal of isolating the "new" gains from trade. Generally speaking, we think of the "new" gains from trade of a country as all welfare effects pertaining to changes in the set of firms serving that country, as emphasized in the "new" trade literature. It is now well-established that such changes are an essential part of an economy's adjustment to trade liberalization. In particular, more firms tend to enter into exporting which are less productive than the average exporter. Also, some firms tend to shut down which are less productive than the average domestic firm.

For concreteness, let us elaborate on our decomposition by considering the welfare effects of CUSFTA on the Canadian economy. On the one hand, one would expect the improved access to the Canadian market to induce additional US firms to start exporting to Canada which would bring about a variety gain $\frac{1}{\sigma-1} \ln \frac{M_{ij}'}{M_{ij}}$. However, these new US exporters are likely to be less productive than the average US exporter given that they did not choose to export originally which would be captured by a productivity loss $\ln \frac{\tilde{\varphi}_{ij}'}{\tilde{\varphi}_{ij}} - \ln \frac{\tilde{\varphi}_{ij}^{c\prime}}{\tilde{\varphi}_{ij}^c}$. Recall that we separately account for the productivity changes of continuing firms so that the terms $\ln \frac{\tilde{\varphi}_{ij}'}{\tilde{\varphi}_{ij}} - \ln \frac{\tilde{\varphi}_{ij}^{c\prime}}{\tilde{\varphi}_{ij}^c}$ always capture pure selection effects.

On the other hand, one would expect the tougher competition from US firms to force some Canadian firms out of the Canadian market which would bring about a variety loss $\frac{1}{\sigma-1} \ln \frac{M_{jj}'}{M_{jj}}$. However, these firms are likely to be less productive than the average Canadian firm so there

driven to zero as a result of free-entry. Of course, per-capita welfare is equal to real per-capita income because the ideal price index measures the minimum cost of acquiring one unit of utility.

would be a counterbalancing productivity gain $\ln \frac{\tilde{\varphi}'_{jj}}{\tilde{\varphi}_{jj}} - \ln \frac{\tilde{\varphi}^{c\prime}_{jj}}{\tilde{\varphi}^{c}_{jj}}$. Notice that these productivity adjustments simply capture that the US and Canadian firms which enter and exit into serving the Canadian market offer their varieties for relatively high prices as a result of their relatively low productivity. This makes them relatively unattractive to Canadian consumers compared to the average US and Canadian firms.

An important implication of this intuition which we will confirm more formally below is that the productivity adjustments can only ever have a modulating character and never overturn the underlying variety effects. In particular, Canadian consumers always gain from additional US varieties no matter how unproductive the new US exporters are. Similarly, Canadian consumers always lose from disappearing Canadian varieties no matter how unproductive the exiting Canadian firms are. At the most basic level, this just reflects the fact that consumers value any variety in a differentiated goods environment as long as it is available for purchase at a finite price.

This means that if there are positive "new" gains from trade in this environment they should be associated with the entry of foreign firms into exporting and not with the exit of domestic firms out of production. While this might seem obvious in light of our discussion, it contradicts the standard narrative presented in the heterogeneous firm literature. In particular, it is usually emphasized that trade liberalization increases average productivity by causing the least productive firms to shut down. While this is true, it just means that consumers lose less from the reduction in the number of domestic varieties than they would if instead the average firm shut down.[8]

An interesting special case of our framework is the Melitz (2003) model with Pareto distributed productivities considered by Arkolakis et al (2012). As we show in the appendix, it implies that $\sum_{i=1}^{N} \frac{\bar{\lambda}_{ij}}{\sigma-1} \ln \frac{M'_{ij}}{M_{ij}} = 0$ and $\sum_{i=1}^{N} \bar{\lambda}_{ij} \left(\ln \frac{\tilde{\varphi}'_{ij}}{\tilde{\varphi}_{ij}} - \ln \frac{\tilde{\varphi}^{c\prime}_{ij}}{\tilde{\varphi}^{c}_{ij}} \right) = 0$ following trade cost reductions so that there are then no "new" gains from trade. In our CUSFTA example, this

[8] It is sometimes observed that trade liberalization not only increases domestic productivity by forcing the least productive firms to exit but also by reallocating resources from less to more productive continuing firms since exporters expand at the expense of non-exporters. To understand the welfare effects of such reallocations, notice that consumers care about their purchasing power in terms of domestic and foreign goods. Clearly, such reallocations do not change the purchasing power of domestic wages in terms of domestic goods since firms charge constant markups over marginal costs. Hence, they can only change the purchasing power of domestic wages in terms of foreign goods which happens if they affect domestic wages relative to foreign wages. As we will explain shortly, such relative wage changes are captured in the "traditional" gains from trade and amount to standard terms-of-trade effects.

would imply that the increased availability of US varieties would be exactly offset by the decreased availability of Canadian varieties in welfare terms. Similarly, the increase in the average productivity of Canadian firms would be exactly offset by the decrease in the average productivity of US exporters in welfare terms.[9]

2.3 Sufficient statistics

Against this background, it becomes clear that standard approaches to estimating the "new" gains from trade tend to capture only partial effects. In particular, existing studies estimating the variety gains from trade typically focus on the increase in the number of imported varieties but downplay the fall in the number of domestically produced varieties (see, for example, Broda and Weinstein, 2006). Similarly, available studies estimating the productivity gains from trade usually emphasize the increase in the average productivity of domestic firms but do not account for the decrease in the average productivity of foreign firms (see, for example, Pavcnik, 2002).

We estimate the "new" gains from trade by expressing them in terms of simple sufficient statistics which are easy to construct from micro data. In particular, we consider the total sales from country i to country j associated with only continuing firms, $X_{ij}^c = M_{ij}^c \left(\frac{\sigma}{\sigma-1} \frac{w_i \tau_{ij}}{\tilde{\varphi}_{ij}^c} \frac{1}{P_j} \right)^{1-\sigma} Y_j$, and express them as a fraction of the total sales from country i to country j associated with all firms, $X_{ij} = M_{ij} \left(\frac{\sigma}{\sigma-1} \frac{w_i \tau_{ij}}{\tilde{\varphi}_{ij}} \frac{1}{P_j} \right)^{1-\sigma} Y_j$, which yields $\frac{X_{ij}^c}{X_{ij}} = \frac{M_{ij}^c}{M_{ij}} \left(\frac{\tilde{\varphi}_{ij}^c}{\tilde{\varphi}_{ij}} \right)^{\sigma-1}$. Notice that these sales correspond to international trade flows if $i \neq j$ and to domestic sales if $i = j$. Upon taking changes and using the fact that the number of continuing firms does not change by definition, we obtain our basic measurement equation,

$$\frac{1}{\sigma-1} \ln \left(\frac{X_{ij}^c / X_{ij}}{X_{ij}^{c\prime} / X_{ij}^{\prime}} \right) = \frac{1}{\sigma-1} \ln \frac{M_{ij}^{\prime}}{M_{ij}} + \left(\ln \frac{\tilde{\varphi}_{ij}^{\prime}}{\tilde{\varphi}_{ij}} - \ln \frac{\tilde{\varphi}_{ij}^{c\prime}}{\tilde{\varphi}_{ij}^c} \right) \quad (2)$$

The intuition underlying this equation can be best seen by further decomposing the sufficient statistic $\frac{1}{\sigma-1} \ln \left(\frac{X_{ij}^c / X_{ij}}{X_{ij}^{c\prime} / X_{ij}^{\prime}} \right)$ which will also be useful in its own right. In particular, we can separate trade flows into their extensive and intensive margins by defining average rev-

[9] Atkeson and Burstein (2010) show that the "indirect effect" of small trade cost reductions is zero in a symmetric two-country Melitz (2003) model even without imposing Pareto because of a combination of free entry and optimal selection. What they refer to as "indirect effect" in their welfare decomposition corresponds to what we call "new gains from trade".

enues $\tilde{r}_{ij} = \left(\frac{\sigma}{\sigma-1}\frac{w_i\tau_{ij}}{\tilde{\varphi}_{ij}}\frac{1}{P_j}\right)^{1-\sigma} Y_j$ and writing $X_{ij} = M_{ij}\tilde{r}_{ij}$. Of course, we can do this for all subsets of firms and time periods so that also $X^c_{ij} = M^c_{ij}\tilde{r}^c_{ij}$, $X'_{ij} = M'_{ij}\tilde{r}'_{ij}$, and $X^{c'}_{ij} = M^c_{ij}\tilde{r}^{c'}_{ij}$. As a result, we can write $\frac{1}{\sigma-1}\ln\left(\frac{X^c_{ij}/X_{ij}}{X^{c'}_{ij}/X'_{ij}}\right)$ as a log differences-in-differences equation in the number of firms and their average revenues comparing continuing firms to all firms in the pre-period and the post-period,

$$\underbrace{\frac{1}{\sigma-1}\ln\left(\frac{X^c_{ij}/X_{ij}}{X^{c'}_{ij}/X'_{ij}}\right)}_{\text{overall "new" gains}} = \underbrace{\underbrace{\frac{1}{\sigma-1}\ln\frac{M^c_{ij}}{M_{ij}}}_{\text{variety loss}} + \underbrace{\frac{1}{\sigma-1}\ln\frac{\tilde{r}^c_{ij}}{\tilde{r}_{ij}}}_{\text{prod. gain}}}_{\text{loss from exit}} \underbrace{- \underbrace{\frac{1}{\sigma-1}\ln\frac{M^c_{ij}}{M'_{ij}}}_{\text{variety gain}} - \underbrace{\frac{1}{\sigma-1}\ln\frac{\tilde{r}^{c'}_{ij}}{\tilde{r}'_{ij}}}_{\text{prod. loss}}}_{\text{gain from entry}} \tag{3}$$

The term $\frac{1}{\sigma-1}\ln\frac{M^c_{ij}}{M_{ij}} = \frac{1}{\sigma-1}\ln\left(1-\frac{M^{ex}_{ij}}{M_{ij}}\right)$ represents the variety loss from exit since all firms in the pre-period can be separated into continuing or exiting firms, $M_{ij} = M^c_{ij} + M^{ex}_{ij}$. Similarly, the term $-\frac{1}{\sigma-1}\ln\frac{M^c_{ij}}{M'_{ij}} = -\frac{1}{\sigma-1}\ln\left(1-\frac{M^{en'}_{ij}}{M_{ij}}\right)$ summarizes the variety gain from entry since all firms in the post-period can be separated into continuing or entering firms, $M'_{ij} = M^c_{ij} + M^{en'}_{ij}$. The revenue ratios simply capture the associated effects on average productivity. In particular, the term $\frac{1}{\sigma-1}\ln\frac{\tilde{r}^c_{ij}}{\tilde{r}_{ij}} = \ln\frac{\tilde{\varphi}^c_{ij}}{\tilde{\varphi}_{ij}}$ measures the productivity change due to exit which one would expect to be positive. Similarly, the term $-\frac{1}{\sigma-1}\ln\frac{\tilde{r}^{c'}_{ij}}{\tilde{r}'_{ij}} = -\ln\frac{\tilde{\varphi}^{c'}_{ij}}{\tilde{\varphi}'_{ij}}$ describes the productivity change due to entry which one would expect to be negative.

Notice that our measurement of the effects of selection on average productivity is quite different from what is usually done in the literature. In particular, the standard approach is based on obtaining measures of productivity levels either by simply computing real output per worker such as Trefler (2004) or by leveraging more complex techniques from the industrial organization literature such as Pavcnik (2002). In contrast, we do not compute productivity levels at all but instead infer the effects selection has on average productivity by comparing the average revenues of continuing firms to the average revenues of all firms within a given time period as suggested by our theory.

We can now also confirm our earlier intuition that exit is always bad and entry is always good regardless of the resulting change in average productivity. In particular, the term labelled "loss from exit" just corresponds to $\ln\frac{X^c_{ij}}{X_{ij}}$ which is negative if there is exit because then $X^c_{ij} < X_{ij}$. Similarly, the term labelled "gain from entry" is simply $-\ln\frac{X^{c'}_{ij}}{X'_{ij}}$ which is positive if there is entry because then $X_{ij}^{c\prime} > X_{ij}^{\prime}$. At the same time, it is important to note that net variety gains are still not necessarily associated with net welfare gains. This is simply because the magnitude of the welfare loss from exit and the magnitude of the welfare gain from entry also depend on the average productivities of the affected firms.

While equations (2) and (3) allow us to compute and decompose the "new" gains from trade, it is also straightforward to calculate the "traditional" gains from trade, at least up to domestic within-firm productivity effects. In particular, we can calculate them as a residual from equation (1) after realizing that the total welfare gains are given by $\ln \frac{W_j^{\prime}}{W_j} = -\frac{1}{\sigma-1} \ln \frac{\lambda_{jj}^{\prime}}{\lambda_{jj}} + \frac{1}{\sigma-1} \ln \frac{M_{jj}^{\prime}}{M_{jj}} + \ln \frac{\tilde{\varphi}_{jj}^{\prime}}{\tilde{\varphi}_{jj}}$ since $\ln \frac{\lambda_{ij}^{\prime}}{\lambda_{ij}} - \ln \frac{\lambda_{jj}^{\prime}}{\lambda_{jj}} = \ln \frac{M_{ij}^{\prime}}{M_{ij}} - \ln \frac{M_{jj}^{\prime}}{M_{jj}} + (1-\sigma)\left(\ln \frac{w_i^{\prime}}{w_i} + \ln \frac{\tau_{ij}^{\prime}}{\tau_{ij}} - \ln \frac{\tilde{\varphi}_{ij}^{\prime}}{\tilde{\varphi}_{ij}} + \ln \frac{\tilde{\varphi}_{jj}^{\prime}}{\tilde{\varphi}_{jj}}\right)$. The only complication is that $\ln \frac{\tilde{\varphi}_{jj}^{\prime}}{\tilde{\varphi}_{jj}}$ is not directly observable and that our earlier logic to recover it only returns changes in average productivity net of within-firm effects, $\ln \frac{\tilde{\varphi}_{jj}^{\prime}}{\tilde{\varphi}_{jj}} - \ln \frac{\tilde{\varphi}_{jj}^{c\prime}}{\tilde{\varphi}_{jj}^{c}} = \frac{1}{\sigma-1}\left(\ln \frac{\tilde{r}_{jj}^{c}}{\tilde{r}_{jj}} - \ln \frac{\tilde{r}_{jj}^{c\prime}}{\tilde{r}_{jj}^{\prime}}\right)$.[10]

The "traditional" gains simply capture what would be the only gains from trade if all firms were continuing firms. Applied to our CUSFTA example, the first term, $\ln \frac{\tau_{ij}^{\prime}}{\tau_{ij}}$, simply describes that trade liberalization makes US varieties cheaper in Canada thereby bringing about consumption gains. The second part, $\ln \frac{w_i^{\prime}}{w_i}$, adds that relative wages can also adjust in response to trade liberalization thus redistributing some of these gains. The third part, $\ln \frac{\tilde{\varphi}_{ij}^{c\prime}}{\tilde{\varphi}_{ij}^{c}}$, accounts for within-firm productivity changes among continuing US and Canadian firms which combine with the changes in trade costs and wages to determine the changes in the prices charged by these firms.[11]

Having said this, it is important to note that these "traditional" gains are also generally affected by firm selection through general equilibrium effects on relative wages so that our "new" gains from trade term should be thought of as capturing only the direct effects. An exception to this is the Arkolakis et al (2012) version of Melitz (2003) with Pareto distributed

[10] Hence, when we measure the traditional gains as a residual, we really measure $\sum_{i=1}^{N} \bar{\lambda}_{ij}\left(-\ln \frac{\tau_{ij}^{\prime}}{\tau_{ij}} - \ln \frac{w_i^{\prime}}{w_i} + \ln \frac{\tilde{\varphi}_{ij}^{c\prime}}{\tilde{\varphi}_{ij}^{c}}\right) - \ln \frac{\tilde{\varphi}_{jj}^{c\prime}}{\tilde{\varphi}_{jj}^{c}}$ instead of $\sum_{i=1}^{N} \bar{\lambda}_{ij}\left(-\ln \frac{\tau_{ij}^{\prime}}{\tau_{ij}} - \ln \frac{w_i^{\prime}}{w_i} + \ln \frac{\tilde{\varphi}_{ij}^{c\prime}}{\tilde{\varphi}_{ij}^{c}}\right)$, thereby not fully accounting for within-firm productivity effects.

[11] Strictly speaking, the last term probably belongs in its own category since neither traditional trade models nor the Melitz (2003) model feature within-firm productivity effects. However, we group it with the traditional gains for simplicity since we do not attempt to separately measure it. To be clear, it reflects changes in the productivity average $\tilde{\varphi}_{ij}^{c} = \left(\int_{\varphi \in \Phi_{ij}^{c}} \varphi^{\sigma-1} dG_i\left(\varphi | \varphi \in \Phi_{ij}^{c}\right)\right)^{\frac{1}{\sigma-1}}$ defined over the fundamental productivity parameters φ of continuing firms.

productivities but this is also the only exception we know. However, relative wage effects are fundamentally about the distribution of the gains from trade across countries and not their overall size. This is simply because relative wage changes translate into terms-of-trade changes given that prices are proportional to marginal costs.[12]

Our formulas for the "new" gains from trade can be roughly thought of as decompositions of the "Feenstra-Ratio" which is widely used to adjust changes in the price index for new product varieties. In particular, it should be easy to verify that Feenstra's (1994) original method yields $\ln \frac{P_j'}{P_j} = \sum_{i=1}^{N} \bar{\lambda}_{ij}^{c} \left(\ln \frac{\tau_{ij}'}{\tau_{ij}} + \ln \frac{w_i'}{w_i} - \ln \frac{\tilde{\varphi}_{ij}^{c\prime}}{\tilde{\varphi}_{ij}^{c}} \right) - \frac{1}{\sigma - 1} \ln \left(\frac{Y_j^c / Y_j}{Y_j^{c\prime} / Y_j'} \right)$ in our environment, where the last term represents the "Feenstra-Ratio". As can be seen, this is closely related to our decompositions $\ln \frac{P_j'}{P_j} = \sum_{i=1}^{N} \bar{\lambda}_{ij} \left(\ln \frac{\tau_{ij}'}{\tau_{ij}} + \ln \frac{w_i'}{w_i} - \ln \frac{\tilde{\varphi}_{ij}^{c\prime}}{\tilde{\varphi}_{ij}^{c}} \right) - \frac{1}{\sigma - 1} \sum_{i=1}^{N} \bar{\lambda}_{ij} \ln \left(\frac{X_{ij}^c / X_{ij}}{X_{ij}^{c\prime} / X_{ij}'} \right)$ and $\ln \frac{P_j'}{P_j} = \sum_{i=1}^{N} \bar{\lambda}_{ij} \left(\ln \frac{\tau_{ij}'}{\tau_{ij}} + \ln \frac{w_i'}{w_i} - \ln \frac{\tilde{\varphi}_{ij}^{c\prime}}{\tilde{\varphi}_{ij}^{c}} \right) - \frac{1}{\sigma - 1} \sum_{i=1}^{N} \bar{\lambda}_{ij} \left(\ln \frac{M_{ij}^c}{M_{ij}} + \ln \frac{\tilde{r}_{ij}^c}{\tilde{r}_{ij}} - \ln \frac{M_{ij}^c}{M_{ij}'} - \ln \frac{\tilde{r}_{ij}^{c\prime}}{\tilde{r}_{ij}'} \right)$ implied by equations (1) - (3).[13]

Our assumption that there is a one-to-one correspondence between varieties and firms is not meant to be taken literally. For example, we will use establishment-level data in our application thereby identifying a variety with a plant. If available, one could even use product-level data thereby also taking into account variety and productivity effects operating within multi-product firms. As a natural generalization of our earlier discussion, one would expect Canadian multi-product firms to shed products and US multi-product exporters to add products following CUSFTA based on the multi-product firms extension of Melitz (2003) proposed by Bernard et al (2011).

2.4 Nontraded and intermediate goods

Before taking our methodology to the data, we incorporate nontraded and intermediate goods in a stylized way. In particular, we assume that consumers spend a share $1 - \mu_j$ of their income

[12] Recall that we have simplified formula (1) by choosing w_j as the numeraire and that it really includes a *relative* wage term, $\sum_{i=1}^{N} \bar{\lambda}_{ij} \left(\ln \frac{w_j'}{w_j} - \ln \frac{w_i'}{w_i} \right)$. This relative wage term has a zero sum character globally which is particularly easy to see in the special case of small shocks. Specifically, it is immediately clear that $\sum_{j=1}^{N} \frac{Y_j}{Y^W} \left(\sum_{i=1}^{N} \lambda_{ij} \left(\frac{dw_j}{w_j} - \frac{dw_i}{w_i} \right) \right) = 0$, where $Y^W = \sum_{j=1}^{N} Y_j$ is world income since equilibrium requires that $Y_j = \sum_m X_{mj}$ and $Y_j = \sum_n X_{jn}$.

[13] We say "roughly" because Feenstra (1994) uses Sato-Vartia weights calculated using shipments of continuing firms, $\bar{\lambda}_{ij}^{c}$, whereas we use Sato-Vartia weights calculated using shipments of all firms, $\bar{\lambda}_{ij}$. Essentially, his adjustment is calculated from the benchmark that there are no entering or exiting firms but only continuing firms whereas our adjustment is calculated from the benchmark that all firms are continuing firms.

on nontraded goods so that the aggregate price index becomes $P_j = \left(P_j^T\right)^{\mu_j} \left(P_j^N\right)^{1-\mu_j}$, where P_j^T and P_j^N are the price indices of traded and nontraded goods. Moreover, we suppose that firms spend a fraction $1-\eta_j$ of their costs on intermediates using the same variety aggregator as consumers so that input costs are given by $c_j = (w_j)^{\eta_j} (P_j)^{1-\eta_j}$. Finally, we impose that nontraded goods are produced under constant returns and perfect competition with productivity φ_j^N so that $P_j^N = \frac{c_j}{\varphi_j^N}$.

Per-capita welfare is then still proportional to real wages given our earlier assumption that final expenditure is proportional to labor income, $W_j \propto \frac{w_j}{P_j}$. Solving $c_j = (w_j)^{\eta_j} (P_j)^{1-\eta_j}$ for w_j and substituting yields $W_j \propto \left(\frac{c_j}{P_j}\right)^{\frac{1}{\eta_j}}$ which can be further manipulated to $W_j \propto \left(\frac{c_j}{P_j^T}\right)^{\frac{\mu_j}{\eta_j}} \left(\varphi_j^N\right)^{\frac{1-\mu_j}{\eta_j}}$ upon substituting $P_j = \left(P_j^T\right)^{\mu_j} \left(P_j^N\right)^{1-\mu_j}$ and $P_j^N = \frac{c_j}{\varphi_j^N}$. Abstracting from productivity changes in the nontraded sector for simplicity, this implies $\ln \frac{W_j'}{W_j} = -\frac{\mu_j}{\eta_j} \ln \frac{P_j^{T\prime}}{P_j^T}$ if c_j is chosen as the numeraire. Given that P_j^T now corresponds to P_j from the earlier model, $\ln \frac{P_j^{T\prime}}{P_j^T}$ can now be decomposed in a perfectly analogous fashion yielding an extended version of formula (1):

$$\ln \frac{W_j'}{W_j} = \underbrace{\frac{\mu_j}{\eta_j} \sum_{i=1}^{N} \bar{\lambda}_{ij} \left(-\ln \frac{\tau_{ij}'}{\tau_{ij}} - \ln \frac{c_i'}{c_i} + \ln \frac{\tilde{\varphi}_{ij}^{c\prime}}{\tilde{\varphi}_{ij}^{c}} \right)}_{\text{"traditional" gains from trade}} + \underbrace{\frac{\mu_j}{\eta_j} \sum_{i=1}^{N} \bar{\lambda}_{ij} \left(\frac{1}{\sigma-1} \ln \frac{M_{ij}'}{M_{ij}} + \left(\ln \frac{\tilde{\varphi}_{ij}'}{\tilde{\varphi}_{ij}} - \ln \frac{\tilde{\varphi}_{ij}^{c\prime}}{\tilde{\varphi}_{ij}^{c}} \right) \right)}_{\text{"new" gains from trade}} \tag{4}$$

As a consequence, the welfare effects from our earlier decomposition (1) simply need to be scaled by $\frac{\mu_j}{\eta_j}$ in order to account for nontraded goods and intermediate goods.[14] Intuitively, nontraded goods dampen the gains from trade because they limit the economy's trade exposure but intermediate goods magnify the gains from trade because they also allow firms to benefit from trade which they then pass on to consumers ultimately. Given the stylized nature of this adjustment, we usually start by reporting our welfare effects without accounting for nontraded and intermediate goods and then report how the overall gains change once we scale them by $\frac{\mu_j}{\eta_j}$.[15]

[14] Notice that μ_j and η_j are easy measurable, corresponding to the economy's expenditure share on traded goods and the share of value added in gross production. To be clear, the weights $\bar{\lambda}_{ij}$ are still defined over traded goods only, $\bar{\lambda}_{ij} = \frac{X_{ij}^T}{Y_j^T}$.

[15] As should be easy to verify, the corresponding sufficient statistics are exactly the same as before. Essentially, they are all calculated from ratios of ratios so that the input cost and price index terms cancel out.

Notice that the interpretation of the gains from trade has to be broadened in the presence of intermediate goods in the sense that they now also include indirect effects on consumer prices operating through changes in intermediate input costs. For example, a "traditional" fall in trade costs or a "new" increase in import variety now also lowers intermediate input costs which firms then pass through to consumer prices since they charge constant markups over marginal costs. Essentially, the gains from trade now also include changes in labor productivity brought about by changes in the prices or number of available intermediate goods.[16]

In the appendix, we explore the robustness of our decomposition to arbitrary firm-level input-output structures which go beyond the simple roundabout formulation developed here. We find that our simple methodology then still accurately measures the direct effects of selection on consumer welfare but that the indirect propagation through the input-output structure also partially shows up in $\ln \frac{\tilde{\varphi}_{ij}^{c\prime}}{\tilde{\varphi}_{ij}^{c}}$. For example, if continuing firms were more likely to self-select into importing, trade liberalization would make their input price index fall by more than the roundabout specification suggests which would then show up as an increase in their average productivity.

3 Application

3.1 Data

We now use our methodology to decompose the welfare effects of CUSFTA on the Canadian economy. CUSFTA was a free trade agreement between Canada and the US which was signed on January 2, 1988. It mandated annual reductions in tariffs and other trade barriers over a ten-year implementation period starting on January 1, 1989 which were accompanied by a significant increase in bilateral trade. In particular, the average tariff imposed against manufacturing imports among the CUSFTA partners fell from over 8% to below 2% in Canada and from 4% to below 1% in the US and bilateral manufacturing trade roughly doubled in

[16] These labor productivity gains are distinct from the productivity gains captured in the term $\ln \frac{\tilde{\varphi}_{ij}^{c\prime}}{\tilde{\varphi}_{ij}^{c}}$ which still reflects changes in the productivity average $\tilde{\varphi}_{ij}^{c} = \left(\int_{\varphi \in \Phi_{ij}^{c}} \varphi^{\sigma-1} dG_i\left(\varphi | \varphi \in \Phi_{ij}^{c}\right)\right)^{\frac{1}{\sigma-1}}$ defined over the fundamental productivity parameters φ of continuing firms.

nominal terms.[17]

CUSFTA can be viewed as a natural experiment which makes it ideal for isolating the effects of trade liberalization. In particular, it was not accompanied by other macroeconomic reforms or implemented in response to a macroeconomic crisis unlike many trade liberalizations in developing countries. Also, it was hard to anticipate since it faced strong political opposition in Canada which was only overcome in a general election on November 21, 1988. As a result, we feel comfortable interpreting our measured welfare effects as gains from trade resulting from CUSFTA but would also like to reiterate that our welfare decomposition is valid regardless of what shock hits the economy.

To implement our methodology, we need information on domestic sales in Canada and exports to Canada before and after CUSFTA came into force broken down into sales by continuing firms, exiting firms, and entering firms. In order to separately identify variety gains and productivity gains, we also need these sales broken down into their extensive and intensive margins which essentially means that we need to know the respective number of firms. As we now explain in more detail, we use micro data from Canada and the US. The US is by far the most important trading partner of Canada accounting for on average 70% of its manufacturing imports during our sample period.

Our Canadian data come from an annual survey of manufacturing establishments which was initially called Census of Manufactures and is now known as Annual Survey of Manufactures. It covers all but the very smallest Canadian manufacturing establishments currently requiring an annual value of shipments of only $30,000 or more. Notice that an accurate representation of small firms is very important for our purposes since we are particularly interested in entering and exiting firms.[18] We do not have direct access to this confidential data and rely on special tabulations provided to us by Statistics Canada when calculating our Canadian estimates.

[17] There were four categories of goods for which different phase-ins applied: Category A, goods for which all tariffs were eliminated on January 1, 1989; Category B: goods for which tariffs were eliminated in five annual steps until January 1, 1993; Category C, goods for which tariffs were eliminated in ten annual steps until January 1, 1998; Category D, goods for which tariffs were already eliminated before CUSFTA. See Figure 1 in Trefler (2004) for an illustration of the time series of tariff cuts.

[18] Baldwin et al (2002) discuss how the entry and exit rates obtained from the Annual Survey of Manufactures compare to the ones obtained from the Business Register or the Longitudinal Employment Analysis Program. They document that they correlate much more highly if long differences are considered which is comforting because we will focus on time spans of 8-10 years.

We have information on the counts and domestic shipments of all, all entering, and all exiting establishments in 1978, 1988, and 1996 at the 2-digit Canadian SIC level. We define an entering establishment as an establishment which was not in the database in the previous year for which we have data, that is in 1978 or 1988. Similarly, we define an exiting establishment as an establishment which was not in the database in the subsequent year for which we have data, that is in 1988 or 1996. Hence, in any time period, establishments can always be separated into entering and continuing ones with respect to the previous time period and exiting and continuing ones with respect to the subsequent time period.

We choose the years 1978, 1988, and 1996 to construct our Canadian summary statistics because those are the years for which Statistics Canada officials were most confident in the sampling frame, resulting in the most reliable decomposition of the establishment population into entering, continuing, and exiting establishments.[19] Despite this precaution, there are still some discrepancies in the reported counts of continuing establishments in adjacent time periods. We correct this, by first adjusting the shares of establishments that are reported to exit until the next period and then recalculating their average revenues so that the total revenues remain unchanged.[20]

Our US data come from the Census of Manufactures which is available every five years. Unfortunately, this census only contains information on exports starting in 1987 so that we restrict attention to the 1987 and 1997 census years leaving us without direct information on US pre-trends. Moreover, exports are not reported by destination so that we have to calculate the sufficient statistics we need using more aggregated data.[21] We use data on the counts of new, continuing, and exiting exporters as well as their average revenues from export shipments which we match to the 2-digit Canadian SIC level using a concordance available

[19] For example, it is well-known that small firms were undercounted in the Annual Survey of Manufactures in the early 1990s due to budget cuts (Baldwin et al, 2002). As we mentioned in the previous footnote, taking long differences also reduces the likelihood of measurement error.

[20] In particular, it should be true that $M_{jj}^{c} = M_{jj}^{c'}$ by definition but we usually observe small deviations from this such that $M_{jj}^{c} > M_{jj}^{c'}$. We correct this by setting M_{jj}^{c} equal to $M_{jj}^{c'}$ and $\tilde{r}_{jj}$ equal to $\frac{M_{jj}^{c}}{M_{jj}^{c'}}\tilde{r}_{jj}$ so that total revenues remain unchanged. We adopt this procedure since sample attrition is the most likely explanation for the discrepancy.

[21] While Canadian customs collects transaction-level data on imports from the US, it is only available from 1992 onwards and also cannot be reliably matched to US firms. In an effort to save resources, US customs does not separately collect transaction-level data on exports to Canada.

from the website of the University of Toronto library.[22]

In our baseline calculations, we use the total number of new, continuing, and exiting US exporters as a proxy for the number of new, continuing, and exiting US exporters to Canada and proceed analogously with the corresponding total and average export revenues. As should be clear from our decompositions (2) and (3), this yields unbiased estimates of the associated welfare effects in simple differences as long as the establishment count, total revenue, and average revenue shares of continuing exporters to all destinations are representative of the establishment count, total revenue, and average revenue shares of continuing exporters to Canada.

Since it is hard to reliably verify the accuracy of this restriction, we interpret our simple-differences results with caution and refer also to our differences-in-differences approach. In this approach, we compare the most and least liberalized Canadian industries so that the treatment effect is accurately measured as long as the error in the restriction differences out. For example, if there was a trend towards entering into exporting to another market which was uncorrelated with Canadian tariff cuts, then this trend would drop out when we take cross-industry differences so that the differential effect of US exports in the most liberalized industries would still be correctly accounted for.

In addition, we also corroborate our US results using trade data instead of micro data by defining a US variety as a Schedule B industry code as is commonly done in the literature (see, for example, Broda and Weinstein 2006). It turns out that the sufficient statistic based on equation (2) is remarkably similar whether it is calculated from micro data or trade data which gives us some confidence in using the trade data to see if US exports to Canada had any major pre-trends. However, the trade data become an unreliable guide when calculating the more detailed decomposition (3) so that we use the micro data as our benchmark throughout the analysis.[23]

[22] Notice that we could also compute the effects of selection on the average productivity of US exporters by comparing the average *domestic* revenues of continuing US exporters to the average *domestic* revenues of all US exporters. We have experimented with this alternative approach and obtained very similar results just as predicted by our theory.

[23] This is likely the result of having many more firms in the micro data than products in the trade data. The micro data likely capture substantial firm entry within schedule B product categories that were already exported to Canada before CUSFTA, while the trade data capture a smaller number of "new export" products that have higher export revenues in part because previously exporting firms as well as newly exporting firms entered in those categories.

We also need estimates of the elasticities of substitution for our calculations and we use the ones from Oberfield and Raval (2014). They are estimated using the 1987 US Census of Manufactures exploiting the condition that markups should equal $\sigma/(\sigma-1)$. They are available from Table VII of their online appendix and we again used the concordance from Peter Schott's website to match them to 2-digit Canadian SIC codes. The matched elasticities range from 3.3 to 4.4 and average to 3.7 which is within the range of alternative estimates in the literature. Whenever we report results using aggregate data, we simply work with this average elasticity of 3.7.

3.2 Aggregate results

3.2.1 Sufficient statistics

We now present the sufficient statistics needed to calculate the "new" gains from CUSFTA on the Canadian economy. Recall that CUSFTA came into force on January 2, 1989 and mandated annual tariff reductions over a 10-year implementation period. Given the years for which we have micro data, we therefore take 1988-1996 to be our "CUSFTA" period for Canada and 1987-1997 to be our "CUSFTA" period for the US which we use to track the effects of CUSFTA on the Canadian economy. In addition, we also construct a "pre-trend" period for Canada ranging from 1978-1988 in order to see if our Canadian micro data is subject to any significant pre-trends.

Table 1 starts by presenting the sufficient statistics needed to calculate the "new" gains from CUSFTA using equation (2). Panel A focuses on exiting, continuing, and entering Canadian firms and summarizes what share of the domestic market they captured among all Canadian firms at the beginning and end of our pre-trend and CUSFTA periods. By definition, the market shares of exiting and continuing firms always sum to 100% at the beginning of a period (firms will exit or not by the end of the period) and the market shares of entering and continuing firms always sum of to 100% at the end of a period (firms have entered or not since the beginning of the period).

As can be seen, these market shares moved just like one would expect given that CUSFTA exposed Canadian firms to tougher competition in the Canadian market by reducing the trade barriers faced by US firms. In particular, the market share of exiting Canadian firms far exceeded the market share of entering Canadian firms in the CUSFTA period resulting in a sharp rise in the market share of continuing Canadian firms. In contrast, the market share of exiting Canadian firms was relatively similar to the market share of entering Canadian firms in the pre-trend period so that there was no major change in the market share of continuing Canadian firms.

Panel B turns to entering, continuing, and exiting US firms following the same logic as Panel A. Entry is now defined as entry into exporting and the market shares are the export market shares of entering US exporters among all US exporters and so on. Just like the domestic market shares of Canadian firms, the export market shares of US exporters also adjusted exactly as one would expect following CUSFTA given that it made exporting more attractive for US firms. In particular, the market share of exiting US exporters was smaller than the market share of entering US exporters in the CUSFTA period resulting in a fall in the market share of continuing US exporters.

While we do not have micro data on US exporters before 1987, we can still get a sense of the pre-trends from the trade data following an approach which is widely used in the literature (see, for example, Broda and Weinstein 2006). In particular, we can simply think of a variety as a disaggregated product category in the trade data and then treat each product category like we would treat an exporting plant in the micro data. We do this at the Schedule B level focusing on exports from the US to Canada. For the CUSFTA period, this requires a crosswalk between HS codes and Schedule B codes that we construct using publicly available concordances.[24]

We first verify that the numbers in Panel B of Table 1 for the CUSFTA period would have been similar had we used trade data instead of micro data and then use the trade data to look at the pre-trend period. In particular, the market share of continuing US exporters was 61.8% in 1987 and 61.4% in 1997 according to the trade data which is very close to the

[24] All trade data is from the Center for International Data at UC Davis. The Schedule B codes were replaced by HS codes in 1989 which were subsequently revised in 1996. We first link the HS codes before and after 1996 using the concordance of Pierce and Schott (2012) and then map this all into Schedule B codes using a concordance available from the Center for International Data at UC Davis. The Schedule B codes are substantially more aggregated than the HS codes so we treat all HS codes which cannot be matched to Schedule B codes as new varieties.

64.5% in 1987 and 61.3% in 1997 obtained using the micro data. Moreover, the market share of continuing US exporters was 88.2% in 1978 and 87.0% in 1987 which suggests that US entry into exporting to Canada and US exit out of exporting to Canada was not subject to any major trends before 1987.[25]

Tables 2 and 3 explore Table 1 further providing the statistics needed to decompose the "new" welfare effects following formula (3). In particular, they separate the sales ratios from Table 1 into the corresponding ratios of firm counts (Table 2) and the corresponding ratios of average sales (Table 3) so that the entries in Table 1 are simply the product of the entries in Table 2 and Table 3. For example, the domestic market share of continuing Canadian firms was 75.6% in 1978 because 48.3% of Canadian firms were continuing firms, the average revenues of continuing firms were equal to 156.5% of the average revenues of all Canadian firms, and $75.6\% = 48.3\% * 156.5\%$.

Table 2 reveals the extensive margin patterns which are underlying the market shares presented in Table 1. Most obviously, it shows that there was a lot of entry and exit among Canadian firms and US exporters with entering and exiting firms accounting for an average 56.2% of all firms. Moreover, it indicates that the number of Canadian firms dropped in the CUSFTA period despite a sharp upward trend in the pre-trend period while the number of US exporters grew dramatically in the CUSFTA period. This can also be seen directly from the total counts of Canadian firms and US exporters which are shown in parentheses in Table 2.[26]

Table 3 complements this by turning to the intensive margin patterns which are underlying the market shares presented in Table 1. As can be seen, continuing firms were much larger than exiting or entering firms which implies that they were also much more productive according to the model we use. While this mechanically implies that exit increases average productivity due to selection and entry decreases average productivity due to selection, we can say more

[25] The results look similar if we look at US exports to all destinations mimicking what we do in the micro data. Then, the market shares of continuing US exporters are 80.8% in 1978 and 82.0% in 1987 for the pre-trend period, and 66.1% in 1987 and 65.0% in 1997 for the CUSFTA period.

[26] The sharp rise in the number of Canadian firms in the pre-trend period is also documented in alternative datasets. For example, Gu et al (2003) find a similar trend using data from the Longitudinal Employment Analysis Program which is available starting in 1983. While we are not aware of any systematic study analyzing the causes of this trend, it correlates with declining unemployment, declining interest rates, and immigration reforms that allowed for "business class" immigration for the first time.

about the net effects of selection by interpreting the revenue shares in Table 3 through the lens of our earlier mapping from average revenues to average productivities, $\ln \frac{\tilde{\varphi}'_{ij}}{\tilde{\varphi}_{ij}} - \ln \frac{\tilde{\varphi}^{c\prime}_{ij}}{\tilde{\varphi}^{c}_{ij}} = \frac{1}{\sigma-1}\left(\ln \frac{\tilde{r}^{c}_{ij}}{\tilde{r}_{ij}} - \ln \frac{\tilde{r}^{c\prime}_{ij}}{\tilde{r}'_{ij}}\right)$.[27]

Specifically, the negative effect of entry on average productivity always dominated the positive effect of exit on average productivity among Canadian and US firms. While the net selection effect was minimal for Canadian firms in the CUSFTA period, it was strikingly large for Canadian firms in the pre-trend period and US exporters in the CUSFTA period. Using the average Oberfield and Raval (2014) elasticity of $\sigma = 3.7$ for our calculations, the net effect of selection on average productivity was -0.4% among Canadian firms in the CUSFTA period, -12.8% among Canadian firms in the pre-trend period, and -17.1% among US exporters in the CUSFTA period.

While the adjustments in the number of Canadian firms, the number of US firms, and the average productivity of US exporters following CUSFTA were therefore exactly as one would expect, the finding that selection implied a slight decrease in the average productivity of Canadian firms is quite surprising at first. One obvious interpretation is that the average productivity of Canadian firms still increased due to selection, just not in absolute terms but relative to the pre-trend. However, we will also find at best weakly positive effects of selection on Canadian productivity in our later differences-in-differences specifications so that this result is actually hinting at a broader theme.

Although methodological differences make it hard to directly compare these results to much of the prior literature, there is earlier work consistent with our finding that selection did not increase productivity in the CUSFTA period. For example, Lileeva (2008) reports that average value added per worker rose by 2.2% among all Canadian plants and by 9.8% among the subset of continuing Canadian plants following CUSFTA which suggests that selection of Canadian plants negatively affected average productivity. According to her analysis, an important driving force of this was that CUSFTA led to substantial exit among large Canadian

[27] As one would expect, we cannot plausibly use the trade data to infer what Tables 2 and 3 might have looked liked if we had micro data for US exporters in the pre-trend period since it fails to capture the massive churning we see in the micro data during the CUSFTA period. For example, the trade data suggests that only 33.8% of all US firms in 1987 exit out of exporting until 1997 whereas the micro data shows that it is actually 54.7%. However, we know from the micro data that the total number of US manufacturing establishments only grew slightly during our sample period (from 317,000 in 1977 to 346,000 in 1987 and then to 361,000 in 1997) which also suggests that there was probably no major pre-CUSFTA trend.

plants that were only serving the Canadian market.[28]

3.2.2 Gains from trade

Table 4 puts all the pieces together and finally calculates the "new" gains from CUSFTA on the Canadian economy. Panels A and B first show the welfare effects of entry and exit by Canadian firms and US exporters respectively, following formula (3). Panel C then turns to the combined effect by aggregating across countries to generate net "new" variety gains and "new" productivity gains", following formula (1). Panel D finally accounts for nontraded and intermediate goods by applying Canada's manufacturing expenditure share μ_j and its share of value added in gross production η_j following formula (4). All values are annualized for better comparability and we again set $\sigma = 3.7$ throughout.[29]

Looking only at the CUSFTA period, we find that the overall "new" gains from CUSFTA were negative for Canada. Not adjusting for nontraded and intermediate goods, Canada's real income increased by 0.20% per year due to "new" variety gains but decreased by a -0.54% per year due to "new" productivity losses resulting in negative "new" gains from trade of -0.34% per year. Underlying this are positive net variety effects of 1.90% per year combined with negative net productivity effects of -1.71% per year resulting from the net entry of US exporters as well as negative net variety effects of -0.50% and negative net productivity effects of -0.05% resulting from the net exit of Canadian firms.

Canada's overall "new" gains from CUSFTA increase to -0.23% when we take simple differences thereby controlling for the pre-trend in Canada. We set all US pre-CUSFTA effects to 0.00% in these calculations since we do not have any US pre-CUSFTA data and the available evidence suggests that there were no major US pre-trends.[30] While the overall welfare effect

[28] These growth rates are calculated from the numbers reported in Lileeva's (2008) Table 1. One caveat is that she defines continuing firms as firms which are active throughout her entire sample period which is from 1980 until 1996 so that the separation into within-firm and between-firm productivity effects in the CUSFTA period is not perfectly clean. We explain how our findings relate to Trefler's (2004) when we discuss our differences-in-differences specifications.

[29] As one would expect, Canadian consumers spend more on Canadian goods than on US goods so that the Canadian effects matter more for the overall "new" gains from trade. In particular, the Sato-Vartia weights are 79.3% and 20.7% in the pre-trend period and 70.7% and 29.3% in the CUSFTA period, with the larger value always representing the weight on domestic goods. We use $\mu_j = 0.32$ and $\eta_j = 0.50$ which are averages of Canada's manufacturing expenditure share and share of value added in gross production yielding an overall adjustment coefficient of $\frac{\mu_j}{\eta_j} = 0.64$.

[30] Recall that our analysis of disaggregated trade data suggested that US exports to Canada were not subject to any major trend in the pre-CUSFTA period. Recall also that the total number of US firms (i.e. exporters

is similar with or without taking differences, the net variety gains and net productivity gains switch signs. In particular, the variety gains become negative while the productivity gains become positive since Canada experienced substantial net entry of underperforming firms in the pre-CUSFTA period.

While these "new" welfare losses are quite large in absolute terms, they are small relative to the "traditional" gains which mainly capture direct consumption gains brought about by lower import prices. Focusing again on the CUSFTA period, we estimate the "traditional" gains from CUSFTA on the Canadian economy to be 0.89% per year which includes all terms from the "traditional" gains expression in formula (1) except for domestic within-firm productivity effects.[31] This is much larger than the negative -0.34% per year "new" gains from CUSFTA and implies that CUSFTA after all had a sizeable positive overall effect on Canadian welfare amounting to 0.55% per year.

Table 4 also allows us to revisit some of our earlier conceptual points. In particular, we proved earlier that entry is always good and exit is always bad in our generic heterogeneous firm environment regardless of the associated productivity effects. This is reflected by the fact that the individual variety gains always dominate the associated productivity losses and the individual variety losses always dominate the associated productivity gains. Moreover, we argued that this is necessarily true only for the gross effects but not for the net effects, an example of which is the dominating effect of net productivity over net variety in the pre-trend period.

As a result, inferring welfare gains from observed productivity increases is more problematic than it might seem. This can be illustrated most clearly with reference to the "Difference" column in Panel A of Table 4 which controls for the pre-CUSFTA trend. As can be seen, the average productivity of Canadian firms increased by 1.22% per year due to selection following CUSFTA relative to the pre-CUSFTA trend. While it is tempting to interpret this as a sure sign of welfare gains, it is actually indicative of underlying net exit which brings about a -0.42% per year net welfare loss since the 1.22% per year productivity gain is overturned by a -1.64% per year variety loss.

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and non-exporters) stays fairly constant over time.

[31] We estimate the traditional gains using the approach explained in section 2.3.

Similarly, Table 4 also confirms our earlier conjecture that partial calculations can yield grossly mismeasured estimates of the "new" gains from trade. In particular, Canada's 1.90% per year net variety gain from the larger number of US exporters is almost entirely offset by its -0.50% per year net variety loss from the lower number of domestic firms once both are appropriately weighted leaving Canada with only a 0.20% per year net variety gain. Also, the -0.05% per year productivity loss from domestic selection is made much worse by the -1.71% per year productivity loss from foreign selection implying an overall -0.54% per year net productivity loss again after taking the appropriate weights into account.

3.2.3 Micro versus macro approach

Table 5 contrasts the net welfare effects presented in Table 4 with the net welfare effects one would obtain if one did not rely on our general framework but instead applied the special case of Melitz (2003) with Pareto distributed productivities considered by Arkolakis et al (2012). In the appendix, we show that changes in the number of firms and their average productivity then depend on changes in trade shares through the relationships $\ln \frac{M'_{ij}}{M_{ij}} = \ln \frac{\lambda'_{ij}}{\lambda_{ij}}$ and $\ln \frac{\tilde{\varphi}'_{ij}}{\tilde{\varphi}_{ij}} - \ln \frac{\tilde{\varphi}^{c\prime}_{ij}}{\tilde{\varphi}^{c}_{ij}} = -\frac{1}{\theta} \ln \frac{\lambda'_{ij}}{\lambda_{ij}}$, where θ is the Pareto shape parameter, all under the assumption that the size of the labor force, the fixed cost of entry, and the fixed cost of accessing domestic and foreign markets remain unchanged.

In order to mimic the results we would obtain if we did not have any micro data, we calculate the net variety and net productivity effects indirectly from the observed changes in trade shares. However, we leverage our micro data to obtain an estimate of the Pareto shape parameter θ which we need for these calculations. In particular, we show in the appendix that $\theta = -\frac{\ln \frac{M'_{ij}}{M_{ij}} - \ln \frac{M'_{ii}}{M_{ii}}}{\ln \frac{\tilde{\varphi}'_{ij}}{\tilde{\varphi}_{ij}} - \ln \frac{\tilde{\varphi}'_{ii}}{\tilde{\varphi}_{ii}}}$ which we can implement using our earlier formula $\ln \frac{\tilde{\varphi}'_{ij}}{\tilde{\varphi}_{ij}} - \ln \frac{\tilde{\varphi}^{c\prime}_{ij}}{\tilde{\varphi}^{c}_{ij}} = \frac{1}{\sigma-1} \left(\ln \frac{\tilde{r}^{c}_{ij}}{\tilde{r}_{ij}} - \ln \frac{\tilde{r}^{c\prime}_{ij}}{\tilde{r}'_{ij}} \right)$ if we assume that $\ln \frac{\tilde{\varphi}^{c\prime}_{ij}}{\tilde{\varphi}^{c}_{ij}} = \ln \frac{\tilde{\varphi}^{c\prime}_{ii}}{\tilde{\varphi}^{c}_{ii}}$. Comparing US exporters to all US firms at the beginning and end of the CUSFTA period, we find $\theta = 2.91$ which is within the range of existing estimates in the literature.

Table 5 does not present a full decomposition following equation (3) but simply reports the "new" variety gains and "new" productivity gains along the lines of formula (1). One difference from Table 4 is that the domestic and foreign components are now already weighted by the appropriate $\bar{\lambda}_{ij}$ so that they immediately sum up to the combined effects. The values under "Baseline" essentially present the same information as Table 4 while the values under "ACR (2012)" report the results obtained from the model of Arkolakis et al (2012). As we explained earlier, the "new" variety and "new" productivity gains then exactly cancel so that there are no "new" gains from trade.

As can be seen, the restricted model does a good job of capturing the negative selection effects on US exporters but is much less successful with respect to all other margins determining the "new" gains from trade. Of course, this is not a coincidence since we have calibrated the Pareto shape parameter using data on US entry into exporting. As a general rule, the restricted model fares better in the specification taking pre-CUSFTA trends into account but even then it fails to approximate the "new" variety gains and "new" productivity gains from trade. Overall, we find that the restricted model substantially overestimates the "new" gains from trade.

3.3 Industry-level results

3.3.1 Multi-industry extension

We now turn to an analysis of the effects of CUSFTA on the Canadian economy at the industry-level with two main goals in mind. First, we would like to check how sensitive our baseline results are to the level of aggregation thereby addressing concerns about aggregation bias which have been raised in the recent literature on the measurement of the gains from trade.[32] Second, we would like to explore the effects of CUSFTA in a differences-in-differences setting comparing the most strongly and the least strongly liberalized industries in order to deal with the possibility that our baseline results also reflect macroeconomic shocks other than the trade liberalization brought about by CUSFTA.[33]

Our analysis is guided by a multi-industry extension of our baseline methodology. In particular, we now assume that our earlier setup applies industry-by-industry allowing for

[32] Ossa (2015), for example, shows that the gains from trade are typically much larger in multi-industry specifications since imports in the "average" industry matter much less than imports in "critical" industries which are essential for the functioning of the economy.

[33] Recall that this is purely an issue of interpretation since our decomposition is valid regardless of what shocks hit the economy.

industries to differ in terms of all model variables and parameters other than wages reflecting free labor mobility within countries between industries. As a result, changes in the ideal industry price indices can be decomposed just like our ideal aggregate price indices earlier, yielding $\ln\frac{P'_{js}}{P_{js}} = \sum_{i=1}^{N}\bar{\lambda}_{ijs}\left(\ln\frac{\tau'_{ijs}}{\tau_{ijs}}+\ln\frac{w'_i}{w_i}-\ln\frac{\tilde{\varphi}^{c\prime}_{ijs}}{\tilde{\varphi}^{c}_{ijs}}\right)-\sum_{i=1}^{N}\bar{\lambda}_{ijs}\left(\frac{1}{\sigma_s-1}\ln\frac{M'_{ijs}}{M_{ijs}}+\left(\ln\frac{\tilde{\varphi}'_{ijs}}{\tilde{\varphi}_{ijs}}-\ln\frac{\tilde{\varphi}^{c\prime}_{ijs}}{\tilde{\varphi}^{c}_{ijs}}\right)\right)$, where s now indexes industries. To be clear, $\bar{\lambda}_{ijs}$ are now defined over industry expenditure shares $\bar{\lambda}_{ijs}=\frac{X_{ijs}}{Y_{js}}$ exactly analogous to the aggregate weights we considered before.

Assuming a nested-CES structure, we now aggregate over these ideal industry price indices in a similar way. In particular, we define the ideal aggregate price index to be a CES aggregate over the ideal industry price indices with an upper-level elasticity ε so that $P_j=\left(\sum_{s=1}^{S}P_{js}^{1-\varepsilon}\right)^{\frac{1}{1-\varepsilon}}$. This implies that the overall expenditure on industry s varieties is given by $Y_{js}=\left(\frac{P_{js}}{P_j}\right)^{1-\varepsilon}Y_j$ so that we can write $P_j=P_{js}\left(\nu_{js}\right)^{\frac{1}{\varepsilon-1}}$ with $\nu_{js}=\frac{Y_{js}}{Y_j}$ being the industry expenditure shares. Taking changes we obtain $\frac{P'_j}{P_j}=\frac{P'_{js}}{P_{js}}\left(\frac{\nu'_{js}}{\nu_{js}}\right)^{\frac{1}{\varepsilon-1}}$ which we can manipulate just as before to yield $\ln\frac{P'_j}{P_j}=\sum_{s=1}^{S}\bar{\nu}_{js}\ln\frac{P'_{js}}{P_{js}}$ after defining $\bar{\nu}_{js}=\frac{\frac{\nu'_{js}-\nu_{js}}{\ln\nu'_{js}-\ln\nu_{js}}}{\sum_{k=1}^{S}\frac{\nu'_{jk}-\nu_{jk}}{\ln\nu'_{jk}-\ln\nu_{jk}}}$. Combining this yields our multi-industry version of equation (1),

$$\ln\frac{W'_j}{W_j} = \underbrace{\sum_{s=1}^{S}\bar{\nu}_{js}\left(\sum_{i=1}^{N}\bar{\lambda}_{ijs}\left(-\ln\frac{\tau'_{ijs}}{\tau_{ijs}}-\ln\frac{w'_i}{w_i}+\ln\frac{\tilde{\varphi}^{c\prime}_{ijs}}{\tilde{\varphi}^{c}_{ijs}}\right)\right)}_{\text{"traditional" gains from trade}} + \underbrace{\sum_{s=1}^{S}\bar{\nu}_{js}\left(\sum_{i=1}^{N}\bar{\lambda}_{ijs}\left(\frac{1}{\sigma_s-1}\ln\frac{M'_{ijs}}{M_{ijs}}+\left(\ln\frac{\tilde{\varphi}'_{ijs}}{\tilde{\varphi}_{ijs}}-\ln\frac{\tilde{\varphi}^{c\prime}_{ijs}}{\tilde{\varphi}^{c}_{ijs}}\right)\right)\right)}_{\text{"new" gains from trade}} \quad (5)$$

Essentially, all this extended formula says is that we can first apply our baseline formula at the industry level and then aggregate across industries using the weights $\bar{\nu}_{js}$. This implies that the welfare effects we discussed earlier now apply at the industry level and it is easy to show that they can also be measured in the same way. In particular, equations (2) and (3) now become $\frac{1}{\sigma_s-1}\ln\left(\frac{X^c_{ijs}/X_{ijs}}{X^{c\prime}_{ijs}/X'_{ijs}}\right)=\frac{1}{\sigma_s-1}\ln\left(\frac{M'_{ijs}}{M_{ijs}}\right)+\left(\ln\frac{\tilde{\varphi}'_{ijs}}{\tilde{\varphi}_{ijs}}-\ln\frac{\tilde{\varphi}^{c\prime}_{ijs}}{\tilde{\varphi}^{c}_{ijs}}\right)$ and $\frac{1}{\sigma_s-1}\ln\left(\frac{X^c_{ijs}/X_{ijs}}{X^{c\prime}_{ijs}/X'_{ijs}}\right)=\frac{1}{\sigma_s-1}\ln\frac{M^c_{ijs}}{M_{ijs}}+\frac{1}{\sigma_s-1}\ln\frac{\tilde{r}^c_{ijs}}{\tilde{r}_{ijs}}-\frac{1}{\sigma_s-1}\ln\frac{M^c_{ijs}}{M'_{ijs}}-\frac{1}{\sigma_s-1}\ln\frac{\tilde{r}^{c\prime}_{ijs}}{\tilde{r}'_{ijs}}$. Again, $\frac{1}{\sigma_s-1}\ln\frac{M^c_{ijs}}{M_{ijs}}-\frac{1}{\sigma_s-1}\ln\frac{M^c_{ijs}}{M'_{ijs}}$ are the variety gains from exit and entry and $\frac{1}{\sigma_s-1}\ln\frac{\tilde{r}^c_{ijs}}{\tilde{r}_{ijs}}-\frac{1}{\sigma_s-1}\ln\frac{\tilde{r}^{c\prime}_{ijs}}{\tilde{r}'_{ijs}}$ are the productivity gains from exit and entry which we now summarize as

$$\underbrace{\frac{1}{\sigma_s - 1} \ln \left(\frac{X^c_{ijs}/X_{ijs}}{X^{c\prime}_{ijs}/X^{\prime}_{ijs}} \right)}_{\text{overall "new" gains}} = \underbrace{\frac{1}{\sigma_s - 1} \ln \frac{M^{\prime}_{ijs}}{M_{ijs}}}_{\text{net variety gains}} + \underbrace{\frac{1}{\sigma_s - 1} \left(\ln \frac{\tilde{r}^c_{ijs}}{\tilde{r}_{ijs}} - \ln \frac{\tilde{r}^{c\prime}_{ijs}}{\tilde{r}^{\prime}_{ijs}} \right)}_{\text{net productivity gains}} \tag{6}$$

We introduce nontraded and intermediate goods exactly as in the baseline model. In particular, we assume that consumers spend a share $1 - \mu_j$ on nontraded goods which are produced under constant returns and perfect competition with constant productivity. Moreover, we assume that firms spend a fraction $1 - \eta_j$ of their costs on intermediates using the same variety aggregator as consumers. For simplicity, we abstract from variation in η_j as well as variation in the intermediate good aggregators across industries. Following the same steps as before, it should be easy to verify that formula (5) then again only needs to be multiplied by $\frac{\mu_j}{\eta_j}$ to incorporate nontraded and intermediate goods yielding:

$$\begin{aligned} \ln \frac{W^{\prime}_j}{W_j} \quad = \quad & \underbrace{\frac{\mu_j}{\eta_j} \sum_{s=1}^{S} \bar{\nu}_{js} \left(\sum_{i=1}^{N} \bar{\lambda}_{ijs} \left(- \ln \frac{\tau^{\prime}_{ijs}}{\tau_{ijs}} - \ln \frac{w^{\prime}_i}{w_i} + \ln \frac{\tilde{\varphi}^{c\prime}_{ijs}}{\tilde{\varphi}^c_{ijs}} \right) \right)}_{\text{"traditional" gains from trade}} \\ & \underbrace{+ \frac{\mu_j}{\eta_j} \sum_{s=1}^{S} \bar{\nu}_{js} \left(\sum_{i=1}^{N} \bar{\lambda}_{ijs} \left(\frac{1}{\sigma_s - 1} \ln \frac{M^{\prime}_{ijs}}{M_{ijs}} + \left(\ln \frac{\tilde{\varphi}^{\prime}_{ijs}}{\tilde{\varphi}_{ijs}} - \ln \frac{\tilde{\varphi}^{c\prime}_{ijs}}{\tilde{\varphi}^c_{ijs}} \right) \right) \right)}_{\text{"new" gains from trade}} \end{aligned} \tag{7}$$

3.3.2 Multi-industry results

We begin by exploring whether our baseline results are subject to aggregation bias by comparing the gains from trade computed by applying formula (1) and (3) using aggregate data to the gains from trade computed by applying formula (5) and (6) using industry-level data. The results are summarized in Table 6 which follows exactly the same format as Table 5. In particular, we again show our aggregate results and then compare them to their industry-level equivalents, each time applying the appropriate Sato-Vartia weights. As can be seen, our findings are similar when using industry-level data with the combined overall "new" gains being almost unchanged.[34]

[34] To be clear, the results under "Aggregate, w/o pre-trend" report $\bar{\lambda}_{ij}\Delta y_{ij}$, where $\bar{\lambda}_{ij}$ are the Sato-Vartia weights from formula (1) and Δy_{ij} are the variety, productivity, or overall gains computed for the CUSFTA period using formula (3). Analogously, the results under "Industry, w/o pre-trend" report $\sum_s \bar{\nu}_{js}\bar{\lambda}_{ijs}\Delta y_{ijs}$, where $\bar{\nu}_{js}$ and $\bar{\lambda}_{ijs}$ are the Sato-Vartia weights from formula (5) and Δy_{ijs} are the variety, productivity, or overall gains computed for the CUSFTA period using formula (5). The results with pre-trends report the

There are two main reasons why we do not find any aggregation bias in contrast to Ossa (2015). First, we work at the 2-digit level and our elasticity estimates do not vary much at that level of disaggregation ranging only between 3.3 and 4.4. Ossa's (2015) point is that only a few critical (i.e. low-elasticity) industries are needed to generate large gains from trade and that such critical industries can typically only be identified at high levels of disaggregation. Second, we only consider relatively small tariff changes instead of the full gains of moving from autarky to current levels of trade so that the access countries have to particular industries does not change that much anyway.

We then exploit cross-industry variation in tariff cuts to assess if our baseline results are indeed driven by CUSFTA. In our calculations, we mainly rely on the tariff cut measures constructed by Trefler (2004) which give the changes in the bilateral tariffs between Canada and the US following CUSFTA net of the changes in the respective most-favored nation (MFN) tariffs. The motivation for considering such changes in bilateral tariff preferences instead of simple bilateral tariff cuts is that Canadian and US MFN tariffs also changed somewhat as a result of the Uruguay Round Agreement which came into force in 1994 towards the end of our CUSFTA period.[35]

Before we discuss our formal results, it is instructive to first look at some simple correlations calculated over our CUSFTA period. Figure 1 plots the industry-level sufficient statistic for Canada's overall "new" gains from domestic entry and exit, $\ln\left(\frac{X^{c}_{jjs}/X_{jjs}}{X^{c\prime}_{jjs}/X^{\prime}_{jjs}}\right)$, against changes in Canada's tariff preferences granted to the US, $\ln\frac{\tau_s^{CAN\prime}}{\tau_s^{CAN}}$, abstracting for now from the elasticity of substitution adjustment $\frac{1}{\sigma_s - 1}$ in order to plot only data. As can be seen, the figure exhibits a strong positive correlation which suggests that the Canadian welfare losses from domestic exit dominate the Canadian welfare gains from domestic entry more in more strongly liberalized industries.

Figures 2 and 3 then break up these overall "new" gains from domestic entry and exit into net variety gains and net productivity gains by considering changes in domestic variety, $\ln\frac{M^{\prime}_{jjs}}{M_{jjs}}$, and changes in domestic average productivity, $\ln\frac{\tilde{r}^{c}_{jj}}{\tilde{r}_{jj}} - \ln\frac{\tilde{r}^{c\prime}_{jj}}{\tilde{r}^{\prime}_{jj}}$, following decomposition

difference between the statistics calculated for the CUSFTA and pre-trend periods.

[35] We thank Trefler for sharing his tariff measures with us. They are originally at the 4-digit level and we aggregate them to the 2-digit level using Canadian imports from the US as weights. We drop the transport equipment industry in all our industry-level calculations because it was already exempted from MFN prior to CUSFTA as a result of the Canada-US Auto Pact (see Trefler, 2004).

(6). While there is a clear positive correlation in Figure 2 implying that the number of domestic varieties falls more in more strongly liberalized industries, the correlation between tariff cuts and average productivity changes is only weakly negative. This already indicates that selection effects only induced small changes in Canadian average productivity which we will confirm more formally below.

Figures 4-6 contain the analogous plots for US exporters, showing how the corresponding overall "new" gains, net variety gains, and net productivity gains correlate with changes in Canada's tariff preferences granted to the US. Figure 4 exhibits a negative correlation which suggests that the overall welfare gains from US entry into exporting dominate the overall welfare losses from US exit out of exporting more in more strongly liberalized industries. Figures 5 and 6 reveal that this negative correlation is again mainly driven by variety instead of productivity effects but overall Canadian tariff cuts clearly have a weaker impact on US exporters than on domestic Canadian firms.

Against this background, we now turn to our differences-in-differences analysis adopting a flexible regression approach following Trefler (2004). The basic idea is to estimate the "new" welfare effects of CUSFTA by first regressing our industry-level sufficient statistics from formula (6) on industry-level tariff cuts and then evaluating the estimated equations at observed tariff cuts disregarding the constant which soaks up any secular trends. While this is not a classic differences-in-differences specification in the sense of comparing treatment industries to control industries, it still identifies the effects of CUSFTA only from cross-industry variation in tariff cuts.

We report our results in Table 7 where we again also include our baseline numbers as a reference. In specification 2, we run industry-level regressions of the form $\Delta y_{ijs} = \beta_0 + \beta_1 \Delta\tau_s^{CAN} + \epsilon_{ijs}$ for our CUSFTA period and then calculate treatment effects from $\sum_s \bar{\nu}_{js}\bar{\lambda}_{ijs}\hat{\beta}_1\Delta\tau_s^{CAN}$, where Δy_{ijs} are the net variety gains, net productivity gains, and overall gains from formula (6), $\Delta\tau_s^{CAN}$ are the log-changes in Canadian tariff preferences granted to the US, $\bar{\nu}_{js}$ and $\bar{\lambda}_{ijs}$ are the Sato-Vartia weights from equation (7), and $\hat{\beta}_1$ is the estimated slope coefficient of the regression line. Essentially, we first calculate the predicted Δy_{ijs} for all industries and then average over them using Sato-Vartia weights.

In specification 3, we then estimate $\Delta y_{ijs} = \beta_0 + \beta_1 \Delta\tau_s^{CAN} + \beta_2 \Delta\tau_s^{US} + \epsilon_{ijs}$ for domestic effects and $\Delta y_{ijs} = \beta_0 + \beta_1 \Delta\tau_s^{CAN} + \beta_2 \Delta\tau_s^{US} + \beta_3 \Delta\tau_s^{MEX} + \epsilon_{ijs}$ for foreign effects and report $\sum_s \bar{\nu}_{js} \bar{\lambda}_{ijs} \left(\hat{\beta}_1 \Delta\tau_s^{CAN} + \hat{\beta}_2 \Delta\tau_s^{US} \right)$, where the new variables are log-changes in US tariff preferences granted to Canada ($\Delta\tau_s^{US}$) and Mexican tariff preferences granted to the US ($\Delta\tau_s^{MEX}$). We also include $\Delta\tau_s^{MEX}$ as controls in our US regressions since our US export data is not broken down by destination and NAFTA also came into force in 1994. Specification 4 simply extends specification 3 by further differencing the Canadian dependent variables with respect to their pre-CUSFTA trends.[36]

As can be seen from Panel C of Table 7, all three differences-in-differences specifications corroborate our earlier result that the combined "new" gains from CUSFTA on the Canadian economy are negative because Canada loses more from the exit of domestic firms out of production than it gains from the entry of US firms into exporting taking variety effects and productivity effects into account. Moreover, these "new" welfare losses remain economically significant in all three specifications bearing in mind that they are reported in annualized terms. For example, specification 2 implies a total (unadjusted) real income loss of $8 * (-0.19\%) = -1.52\%$ over our 8-year CUSFTA period.

While the differences-in-differences results therefore broadly confirm our earlier conclusions, they also allow us to make some additional points. In particular, Panel A of Table 7 shows that the foreign variety gains fall sharply in our differences-in-differences specifications which suggests that the US entry into exporting measured in our baseline specification is explained largely by a secular trend. Moreover, Panel B of Table 7 highlights that the productivity effects due to domestic selection are small in all specifications and only have the expected sign in specifications 2 and 3 which might seem surprising given that Trefler (2004) reports that domestic selection increased Canadian productivity.

However, Trefler's (2004) and our findings are actually easy to reconcile. In particular, Trefler (2004) also reports that the average employment of all firms grows about as fast as the average employment of continuing firms, $\frac{\tilde{l}'_{jjs}}{\tilde{l}_{jjs}} \approx \frac{\tilde{l}^{c\prime}_{jjs}}{\tilde{l}^{c}_{jjs}}$, when analyzing the employment effects of CUSFTA. When interpreted through the lens of our model, this immediately implies that

[36] We construct the Mexican tariff preferences granted to the US from Kowalczyk and Davis (1998). We do not include $\hat{\beta}_3 \Delta\tau_s^{MEX}$ when calculating the average treatment effects for the US because we are interested in the average treatment effect of CUSFTA in which Mexico is not involved. Recall that we only have data on the pre-CUSFTA period for Canada so that we cannot control for pre-CUSFTA trends when we estimate the US effects.

$\ln \frac{\tilde{\varphi}'_{jjs}}{\tilde{\varphi}_{jjs}} - \ln \frac{\tilde{\varphi}^{c\prime}_{jjs}}{\tilde{\varphi}^{c}_{jjs}} \approx 0$ from formula (6) since $\ln \frac{\tilde{r}^{c}_{jjs}}{\tilde{r}_{jjs}} - \ln \frac{\tilde{r}^{c\prime}_{jjs}}{\tilde{r}'_{jjs}} = \ln \frac{\tilde{l}^{c}_{jjs}}{\tilde{l}_{jjs}} - \ln \frac{\tilde{l}^{c\prime}_{jjs}}{\tilde{l}'_{jjs}}$ given that average revenues are proportional to the average wage bill. Hence, our conclusion differs from Trefler's (2004) not because we have different findings but because our model tells us to interpret the findings differently.

Essentially, our measurement of firm productivity differs from Trefler's (2004) in fundamental ways. In particular, we adopt firm revenue as a size-based measure of firm productivity and calculate the effects of selection on average productivity by comparing the average revenues of continuing firms and all firms. This works because relative firm revenues are log-proportional to relative firm productivities in our model since all other determinants of firm revenues drop out. Trefler (2004) instead calculates firm productivity by deflating nominal value added per worker with producer price indices which is inconsistent with the Melitz (2003) model our decomposition is based on.

To see this, take the standard Melitz (2003) model and consider as an example a non-exporting Canadian firm. Using the average price $\tilde{p}_{jjs}$ as a producer price deflator, it should be easy to verify that the statistic calculated by Trefler (2004) is $\frac{p_{jjs}(\varphi)q_{jjs}(\varphi)}{\tilde{p}_{jjs}l_{jjs}(\varphi)} = \tilde{\varphi}_{jjs}\frac{l^{v}_{jjs}(\varphi)}{l^{v}_{jjs}(\varphi)+f_{js}}$, where employment is split into a fixed and a variable part, $l_{jjs}(\varphi) = f_{js} + l^{v}_{jjs}(\varphi)$. As can be seen, this statistic only measures a function of firm productivity but not firm productivity itself so that additional steps would have to be taken to accurately recover firm productivity. Moreover, it relies critically on taking the model's fixed cost assumption literally because otherwise value added per worker would be the same across firms.[37,38]

Tables 8-10 report all regression results underlying the differences-in-differences calcula-

[37] For our purposes, an important additional drawback of using real value added per worker is that it also takes into account resource reallocations from less to more productive *continuing* firms such as from non-exporters to exporters when it is computed at the industry-level. As we explained in footnote 8, such resource reallocations are only welfare relevant to the extent that they change the terms-of-trade of the country and should therefore not be included in our measure of the direct "new" gains. Notice that this issue also somewhat confounds the abovementioned link between our productivity results and Trefler's (2004) employment results because our theory would strictly speaking suggest to look only at the variable employment devoted to producing goods for the domestic market not taking export activities into account. Indeed, this is precisely why we focus on the domestic revenues instead of the total revenues of Canadian firms in our application so that we perform our calculations in a fully theory-consistent way.

[38] Interestingly, Segerstrom and Sugita (2015) have recently shown that average productivity should actually fall in more deeply liberalized industries in a standard multi-sector Melitz (2003) model contrary to what is commonly thought. The intuition for this is that unilateral trade liberalization actually makes industries less competitive in standard multi-sector models of monopolistic competition and free entry following the logic of Venables (1987). This mechanism might help explain why we do not find any strong average productivity effects which would be interesting to explore.

tions shown in Table 7. Table 8 effectively just puts numbers on the correlations shown in Figures 1-6 now also taking into account heterogeneity in $\frac{1}{\sigma_s - 1}$. As the figures suggest, Canada's tariff cuts against the US are significantly related to Canada's variety gains and overall "new" gains but not to Canada's productivity gains. The main message from Tables 9 and 10 is that US tariff cuts against Canada and Mexican tariff cuts against the US are not significantly related to any of our sufficient statistics which is not too surprising since we are measuring the effects of CUSFTA on the Canadian economy.[39]

Figures 7-10 explore the domestic welfare effects further by looking at exit and entry separately. In particular, Figures 7 and 8 show the exit and entry effects underlying the net entry results plotted in Figure 1 using an industry-level version of our earlier decomposition (3). Interestingly, the net effects are driven much more by exit than entry which is further explored in Figures 9 and 10. Figure 9 shows that the gross variety losses are even more strongly related to Canadian tariff cuts than the net variety losses depicted in Figure 2. Also, Figure 10 now shows a clear relationship between Canadian tariff cuts and productivity gains when only the exiting firms are taken into account.

4 Conclusion

In this paper, we measured the "new" gains from trade reaped by Canada as a result of CUSFTA. We thought of the "new" gains from trade of a country as all welfare effects pertaining to changes in the set of firms serving that country as emphasized in the "new" trade literature. To this end, we first developed an exact decomposition of the gains from trade based on a general heterogeneous firm model which allowed us to account for "traditional" and "new" gains using simple sufficient statistics. We then applied this decomposition using Canadian and US micro data and found that the "new" welfare effects of CUSFTA on Canada were negative.

[39] Recall that we included Mexican tariff cuts in our US regressions because we worried that our US results could be partially driven by NAFTA which came into force in 1994. While Tables 9-10 suggest that this worry was unjustified, we still cannot fully rule out that NAFTA affected our Canadian results. This is because Canadian tariff cuts against Mexico following NAFTA were by construction correlated with Canadian tariff cuts against the US following CUSFTA because both trade agreements ultimately phased out MFN tariffs. However, the biases resulting from this correlation are probably small given the dominant role of the US among Canada's trading partners and the large time gap between CUSFTA and NAFTA.

Given the usual narrative that trade liberalization expands import variety and improves domestic productivity, how is it possible that we find negative "new" gains from trade? The narrow answer is simply that import variety gains are counteracted by domestic variety losses, and domestic productivity gains are counteracted by foreign productivity losses, which are brought about by the fact that trade liberalization allows less productive foreign firms to enter into exporting. Essentially, trade liberalization brings about selection effects among domestic producers and foreign exporters which all have to be taken into consideration for an accurate measurement of the "new" gains from trade.

But taking this logic one step further, the broader point is that the distinction between variety effects and productivity effects can easily become misleading because exit is always welfare reducing and entry is always welfare improving regardless of the associated productivity effects. Really, the productivity effects only have an attenuating character in the sense that losing a low productivity firm is less harmful than losing a high productivity one. While we have shown this formally only in our particular model, this is probably a general point because it seems impossible for firm exit to improve consumer welfare as long as consumers originally chose to buy from the exiting firms.

Having said this, it is also important to remember that our finding of negative "new" gains from CUSFTA does not imply that CUSFTA actually left Canada worse off. On the contrary, the "traditional" gains far outweighed the "new" welfare losses according to our calculations so that Canada actually reaped substantial gains from trade. Moreover, our measure of the "new" gains from trade accounts only for selection effects and did not include any within-firm productivity effects which we instead ascribed to the "traditional" gains from trade. Earlier work such as Trefler (2004) has found that within-firm productivity also increased as a result of CUSFTA and we have nothing to add to this debate.

Let us close with two concrete suggestions for future work. First, it would be interesting to explore what specific restrictions on the determinants of entry into production and exporting or the distribution of firm productivities are necessary to predict the adjustments to CUSFTA we describe. We already know that the restrictions imposed by Arkolakis et al (2012) lead to an overestimate of the "new" gains from trade so it would have to be some deviation from the benchmark they describe. Second, it would be interesting to extend our empirical analysis beyond two countries, preferably by adding micro data from other countries but alternatively by using disaggregated trade data.

5 Appendix

5.1 Special case of Arkolakis et al (2012)

This appendix presents a version of Melitz (2003) considered by Arkolakis et al (2012) and derives the associated expressions mentioned in the main text. This is a special case of our model because it imposes a specific entry process and assumes Pareto distributed productivities. In particular, entrants into country i have to hire f_i^e units of labor in country i before drawing their productivities, where f_i^e is a fixed cost of entry. Moreover, entrants into country i wishing to serve market j have to hire f_{ij} unit of labor in country j, where f_{ij} is a fixed market access costs. Firms draw their productivities from $G_i(\varphi) = 1 - \left(\frac{A_i}{\varphi}\right)^\theta$, where A_i is the Pareto location parameter, and θ is the Pareto shape parameter.

A country i firm then only exports to country j if its productivity exceeds φ_{ij}^* which is implicitly defined by $r_{ij}\left(\varphi_{ij}^*\right) = \sigma w_j f_{ij}$ so that $\tilde{r}_{ij} = \left(\frac{\tilde{\varphi}_{ij}}{\varphi_{ij}^*}\right)^{\sigma-1} \sigma w_j f_{ij}$ and $\lambda_{ij} = M_{ij}\left(\frac{\tilde{\varphi}_{ij}}{\varphi_{ij}^*}\right)^{\sigma-1} \frac{\sigma f_{ij}}{L_j}$. Upon noticing that $\tilde{\varphi}_{ij} = \left(\frac{\theta}{\theta-\sigma+1}\right)^{\frac{1}{\sigma-1}} \varphi_{ij}^*$ under Pareto and holding constant f_{ij} and L_i, this implies $\ln\lambda'_{ij} - \ln\lambda_{ij} = \ln\frac{M'_{ij}}{M_{ij}}$ so that $\sum_{i=1}^N \bar{\lambda}_{ij}\ln\frac{M'_{ij}}{M_{ij}} = 0$, as claimed in the main text. Imposing free entry, it is easy to show that $M_{ij} = \left(\frac{A_i}{\varphi_{ij}^*}\right)^\theta \frac{L_i}{\frac{\theta\sigma}{\sigma-1}f_i^e}$ so that also $\sum_{i=1}^N \bar{\lambda}_{ij}\left(\ln\frac{\tilde{\varphi}'_{ij}}{\tilde{\varphi}_{ij}} - \ln\frac{A'_i}{A_i}\right) = 0$ if f_i^e does not change, which is what was claimed in the main text since now $\frac{A'_i}{A_i} = \frac{\tilde{\varphi}_{ij}^{c\prime}}{\tilde{\varphi}_{ij}^c}$. The same equations and restrictions also immediately yield the other relationships mentioned in the main text, i.e. $\theta = -\frac{\ln\frac{M'_{ij}}{M_{ij}} - \ln\frac{M'_{ii}}{M_{ii}}}{\ln\frac{\tilde{\varphi}'_{ij}}{\tilde{\varphi}_{ij}} - \ln\frac{\tilde{\varphi}'_{ii}}{\tilde{\varphi}_{ii}}}$, $\ln\frac{M'_{ij}}{M_{ij}} = \ln\frac{\lambda'_{ij}}{\lambda_{ij}}$, and $\ln\frac{\tilde{\varphi}'_{ij}}{\tilde{\varphi}_{ij}} - \ln\frac{\tilde{\varphi}_{ij}^{c\prime}}{\tilde{\varphi}_{ij}^c} = -\frac{1}{\theta}\ln\frac{\lambda'_{ij}}{\lambda_{ij}}$.

5.2 Allowing for arbitrary firm-level input-output structures

This appendix explores the robustness of our decomposition to arbitrary firm-level input-output structures which go beyond the simple roundabout formulation from subsection 2.4. In particular, suppose that the intermediate goods price index of firm φ in country j is given by $P_j^I(\varphi) = \left(\sum_{i=1}^N \int_{\varphi'\in\Phi_{ij}^I(\varphi)} p_{ij}(\varphi')^{1-\sigma} dG\left(\varphi'|\varphi' \in \Phi_{ij}^I(\varphi)\right)\right)^{\frac{1}{1-\sigma}}$, where $\Phi_{ij}^I(\varphi)$ is the subset of firms from country i supplying intermediate goods to firm φ in country j. Maintaining our earlier assumption that firms spend a fraction $1-\eta_i$ of their costs on intermediates, this implies that the input costs of firm φ in country i can be written as $c_i(\varphi) = (w_i)^{\eta_i} \left(P_i^I(\varphi)\right)^{1-\eta_i}$ which yields the pricing formula $p_{ij}(\varphi) = \frac{\sigma}{\sigma-1} \frac{c_i(\varphi)\tau_{ij}}{\varphi}$.

Using the roundabout input costs $c_i = (w_i)^{\eta_i} (P_i)^{1-\eta_i}$ as a benchmark, we can expand the pricing formula to $p_{ij}(\varphi) = \frac{\sigma}{\sigma-1} \frac{c_i \tau_{ij}}{\frac{c_i}{c_i(\varphi)}\varphi}$ and again express aggregate trade flows as $X_{ij} = M_{ij} \left(\frac{\tilde{p}_{ij}}{P_j}\right)^{1-\sigma} Y_j$ and average prices as $\tilde{p}_{ij} = \frac{\sigma}{\sigma-1} \frac{c_i}{\tilde{\varphi}_{ij}}$. However, we now have to use a generalized notion of average productivity $\tilde{\varphi}_{ij} = \left(\int_{\varphi \in \Phi_{ij}} \left(\frac{c_i}{c_i(\varphi)}\varphi\right)^{\sigma-1} dG_i\left(\varphi | \varphi \in \Phi_{ij}\right)\right)^{\frac{1}{\sigma-1}}$ which is defined over adjusted productivity levels $\frac{c_i}{c_i(\varphi)}\varphi$ thereby taking deviations in the access to intermediate goods from the roundabout benchmark into account. Conditional on this generalization, our sufficient statistic (2) and decomposition (4) remain completely unchanged, as should be easy to verify.

The interpretation of this is that our original sufficient statistic (2) still accurately measures the direct effects of selection on consumer welfare by calculating the average productivity changes associated with entry and exit using the adjusted firm productivities $\frac{c_i}{c_i(\varphi)}\varphi$. However, our original decomposition (4) now provides an oversimplified accounting of the indirect propagation of these effects through the input-output structure by merely scaling all direct effects by $\frac{1}{\eta_j}$. This results in an error which becomes part of the change in the average productivity of continuing firms $\ln \frac{\tilde{\varphi}_{ij}^{c\prime}}{\tilde{\varphi}_{ij}^{c}}$ which we anyway do not attempt to measure and subsume under the "traditional" gains.

This can be seen most clearly by writing the expression for $\tilde{\varphi}_{ij}^{c}$ in changes which yields $\frac{\tilde{\varphi}_{ij}^{c\prime}}{\tilde{\varphi}_{ij}^{c}} = \left(\int_{\varphi' \in \Phi_{ij}^{c\prime}} \frac{r_{ij}(\varphi)}{\tilde{r}_{ij}^{c}} \left(\frac{P_i'/P_i}{P_i^{I\prime}(\varphi')/P_i^I(\varphi)}\right)^{(1-\eta_i)(\sigma-1)} \left(\frac{\varphi'}{\varphi}\right)^{\sigma-1} dG_i'\left(\varphi' | \varphi' \in \Phi_{ij}^{c\prime}\right)\right)^{\frac{1}{\sigma-1}}$ and shows that the growth rate of $\tilde{\varphi}_{ij}^{c}$ now also depends on the growth rate of $P_i^I(\varphi)$ relative to P_i. For example, if continuing firms were more likely to self-select into importing, trade liberalization would make their price index fall by more than the roundabout specification suggests, which would then show up as an increase in their average productivity. Without firm-level input-output data which would permit a direct estimation of $\frac{P_i^{I\prime}(\varphi')}{P_i^I(\varphi)}$ following our methodology, this could be explored further by making functional form assumptions on the relationship $\Phi_{ij}^{I}(\varphi)$.

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TABLE 1: OVERALL MARKET SHARES

A: Market shares of Canadian plants

Pre-trend				CUSFTA			
1978		**1988**		**1988**		**1996**	
Exit	Cont.	Cont.	Enter	Exit	Cont.	Cont.	Enter
24.4%	75.6%	78.4%	21.6%	28.0%	72.0%	81.2%	18.8%

B: Market shares of US exporters

CUSFTA			
1987		**1997**	
Exit	Cont.	Cont.	Entry
35.5%	64.5%	61.3%	38.7%

Notes: Panel A shows the domestic market shares of entering, continuing, and exiting Canadian plants among all Canadian plants. Panel B shows the export market shares of entering, continuing, and exiting US exporters among all US exporters.

TABLE 2: EXTENSIVE MARGINS OF MARKET SHARES

A: Shares of Canadian plants

Pre-trend				CUSFTA			
1978		**1988**		**1988**		**1996**	
Exit	Cont.	Cont.	Enter	Exit	Cont.	Cont.	Enter
51.7%	48.3%	35.5%	64.5%	49.6%	50.4%	56.2%	43.8%
(28,000 plants)		(38,000 plants)		(38,000 plants)		(34,000 plants)	

B: Shares of US exporters

CUSFTA			
1987		**1997**	
Exit	Cont.	Cont.	Entry
54.7%	45.3%	27.1%	72.9%
(29,000 plants)		(48,000 plants)	

Notes: Panel A shows the fraction of entering, continuing, and exiting Canadian plants among all Canadian plants. Panel B shows the fraction of entering, continuing, and exiting US exporters among all US exporters. The numbers in parentheses give the total number of active plants or exporters rounded to the nearest 1,000.

TABLE 3: INTENSIVE MARGINS OF MARKET SHARES

A: Relative sizes of Canadian plants

Pre-trend				CUSFTA			
1978		**1988**		**1988**		**1996**	
Exit	Cont.	Cont.	Enter	Exit	Cont.	Cont.	Enter
47.2%	156.5%	220.7%	33.4%	56.5%	142.7%	144.4%	43.0%
(-12.8% productivity loss)				(-0.4% productivity loss)			

B: Relative sizes of US exporters

CUSFTA			
1987		**1997**	
Exit	Cont.	Cont.	Enter
64.9%	142.4%	225.9%	53.1%
(-17.1% productivity loss)			

Notes: Panel A shows the average domestic sales of entering, continuing, and exiting Canadian plants as a share of the average domestic sales of all Canadian plants. Panel B shows the average foreign sales of entering, continuing, and exiting US exporters as a share of the average foreign sales of all US exporters. The numbers in parentheses give the implied average productivity growth rates due to selection assuming σ=3.7.

TABLE 4: "NEW" GAINS FROM CUSFTA OF CANADA

A: Annualized welfare effects of domestic entry and exit (Canadian plants)

	Pre-trend	**CUSFTA**	**Difference**
Net welfare effect	-0.14%	-0.56%	-0.42%
Net variety effect	1.14%	-0.50%	-1.64%
Net productivity effect	-1.28%	-0.05%	1.22%
Welfare loss from exit	-1.04%	-1.52%	-0.49%
Variety loss	-2.69%	-3.17%	-0.47%
Productivity gain	1.66%	1.65%	-0.01%
Welfare gain from entry	0.90%	0.96%	0.07%
Variety gain	3.83%	2.66%	-1.17%
Productivity loss	-2.93%	-1.70%	1.23%

B: Annualized welfare effects of foreign entry and exit (US exporters)

	CUSFTA	**Difference**
Net welfare effect	0.19%	0.19%
Net variety effect	1.90%	1.90%
Net productivity effect	-1.71%	-1.71%
Welfare loss from exit	-1.62%	-1.62%
Variety loss	-2.93%	-2.93%
Productivity gain	1.31%	1.31%
Welfare gain from entry	1.81%	1.81%
Variety gain	4.83%	4.83%
Productivity loss	-3.02%	-3.02%

C: Annualized overall welfare effects of entry and exit

	Pre-trend	**CUSFTA**	**Difference**
"New" gains from trade	-0.11%	-0.34%	-0.23%
"New" variety gains	0.90%	0.20%	-0.70%
"New" productivity gains	-1.01%	-0.54%	0.47%

D: Adjusted annualized overall welfare effects of entry and exit ($\mu,\eta \neq 1$)

	Pre-trend	**CUSFTA**	**Difference**
"New" gains from trade	-0.07%	-0.22%	-0.15%
"New" variety gains	0.58%	0.13%	-0.45%
"New" productivity gains	-0.65%	-0.34%	0.30%

Notes: This table decomposes the "new" gains from CUSFTA on the Canadian economy. Panel A shows the unweighted welfare effects arising from the entry and exit of Canadian plants calculated using formula (3). Panel B shows the unweighted welfare effects arising from the entry and exit of US exporters calculated using formula (3). Panel C applies formula (1) and averages between the values from Panels A and B using the Sato-Vartia weights to obtain the overall welfare effects of CUSFTA on the Canadian economy. Panel D further accounts for nontraded and intermediate goods following formula (4). All values are reported in annualized terms by taking simple averages and assume σ=3.7.

TABLE 5: BASELINE MODEL VERSUS ACR (2012) SPECIAL CASE

A: Annualized "new" variety gains

	Baseline		**ACR (2012)**	
	w/o pre-trend	**w/ pre trend**	**w/o pre-trend**	**w/ pre trend**
Domestic (weighted)	-0.36%	-1.26%	-0.78%	-0.73%
Foreign (weighted)	0.56%	0.56%	0.78%	0.73%
Combined	0.20%	-0.70%	0.00%	0.00%

B: Annualized "new" productivity gains

	Baseline		**ACR (2012)**	
	w/o pre-trend	**w/ pre trend**	**w/o pre-trend**	**w/ pre trend**
Domestic (weighted)	-0.04%	0.97%	0.73%	0.68%
Foreign (weighted)	-0.50%	-0.50%	-0.73%	-0.68%
Combined	-0.54%	0.47%	0.00%	0.00%

C: Annualized overall "new" gains

	Baseline		**ACR (2012)**	
	w/o pre-trend	**w/ pre trend**	**w/o pre-trend**	**w/ pre trend**
Domestic (weighted)	-0.39%	-0.28%	-0.05%	-0.05%
Foreign (weighted)	0.06%	0.06%	0.05%	0.05%
Combined	-0.34%	-0.23%	0.00%	0.00%

D: Adjusted annualized overall "new" gains ($\mu,\eta \neq 1$)

	Baseline		**ACR (2012)**	
	w/o pre-trend	**w/ pre trend**	**w/o pre-trend**	**w/ pre trend**
Domestic (weighted)	-0.25%	-0.18%	-0.04%	-0.03%
Foreign (weighted)	0.04%	0.04%	0.04%	0.03%
Combined	-0.22%	-0.15%	0.00%	0.00%

Notes: This table compares the "new" gains from CUSFTA from Table 4 which are calculated using formula (1) (under "Baseline") to the "new" gains from CUSFTA obtained from the Melitz (2003) model used by Arkolakis et al (2012) which is a special case of ours (under "ACR (2012)"). All welfare effects are given in annualized terms, are weighted by their corresponding Sato-Vartia weights, and assume σ=3.7. The entries under "w/o pre-trend" look at the post-CUSFTA period and the entries under w/ pre-trend look at the difference between the post-CUSFTA and the pre-CUSFTA period. Panel D adjusts for nontraded and intermediate goods following formula (4).

TABLE 6: BASELINE MODEL VERSUS INDUSTRY DIFFERENCES

	Baseline		Industry	
A: Annualized "new" variety gains				
	w/o pre-trend	**w/ pre trend**	**w/o pre-trend**	**w/ pre trend**
Domestic (weighted)	-0.36%	-1.26%	-0.25%	-0.85%
Foreign (weighted)	0.56%	0.56%	0.44%	0.44%
Combined	0.20%	-0.70%	0.20%	-0.41%
B: Annualized "new" productivity gains				
	w/o pre-trend	**w/ pre trend**	**w/o pre-trend**	**w/ pre trend**
Domestic (weighted)	-0.04%	0.97%	-0.12%	0.57%
Foreign (weighted)	-0.50%	-0.50%	-0.40%	-0.40%
Combined	-0.54%	0.47%	-0.52%	0.17%
C: Annualized overall "new" gains				
	w/o pre-trend	**w/ pre trend**	**w/o pre-trend**	**w/ pre trend**
Domestic (weighted)	-0.39%	-0.28%	-0.36%	-0.28%
Foreign (weighted)	0.06%	0.06%	0.04%	0.04%
Combined	-0.34%	-0.23%	-0.33%	-0.24%
D: Adjusted annualized overall "new" gains (μ,η≠1)				
	w/o pre-trend	**w/ pre trend**	**w/o pre-trend**	**w/ pre trend**
Domestic (weighted)	-0.25%	-0.18%	-0.23%	-0.18%
Foreign (weighted)	0.04%	0.04%	0.02%	0.02%
Combined	-0.22%	-0.15%	-0.21%	-0.16%

Notes: This table compares the "new" gains from CUSFTA from Table 4 which are calculated from formula (1) using aggregate data (under "Baseline") to the "new" gains from CUSFTA calculated from formula (5) using industry-level data (under "Industry"). All welfare effects are given in annualized terms and are weighted by their corresponding Sato-Vartia weights. The aggregate results assume σ=3.7 while the industry-level result impose the Oberfield and Raval (2014) elasticities. The entries under "w/o pre-trend" look at the post-CUSFTA period and the entries under "w/ pre-trend" look at the difference between the post-CUSFTA and the pre-CUSFTA period. Panel D adjusts for nontraded and intermediate goods following formulas (4) and (7).

TABLE 7: BASELINE MODEL VS. INDUSTRY DIFFERENCES-IN-DIFFERENCES

A: Annualized "new" variety gains				
	(1) Baseline	**(2) Diff-in-diff, CAN tariffs only**	**(3) Diff-in-diff, full CUSFTA**	**(4) Diff-in-diff, full CUSFTA w/ pre-trends**
Domestic (weighted)	-0.36%	-0.26%	-0.27%	-0.20%
Foreign (weighted)	0.56%	0.03%	0.02%	0.02%
Combined	0.20%	-0.23%	-0.26%	-0.18%

B: Annualized "new" productivity gains				
	(1) Baseline	**(2) Regression, CAN tariffs only**	**(3) Regression, full CUSFTA**	**(4) Regression, full CUSFTA w/ pre-trends**
Domestic (weighted)	-0.04%	0.04%	0.05%	-0.02%
Foreign (weighted)	-0.50%	-0.02%	0.00%	0.00%
Combined	-0.54%	0.02%	0.06%	-0.02%

C: Annualized overall "new" gains				
	(1) Baseline	**(2) Regression, CAN tariffs only**	**(3) Regression, full CUSFTA**	**(4) Regression, full CUSFTA w/ pre-trends**
Domestic (weighted)	-0.39%	-0.22%	-0.22%	-0.22%
Foreign (weighted)	0.06%	0.03%	0.02%	0.02%
Combined	-0.34%	-0.19%	-0.20%	-0.20%

D: Adjusted annualized overall "new" gains (μ,η≠1)				
	(1) Baseline	**(2) Regression, CAN tariffs only**	**(3) Regression, full CUSFTA**	**(4) Regression, full CUSFTA w/ pre-trends**
Domestic (weighted)	-0.25%	-0.14%	-0.14%	-0.14%
Foreign (weighted)	0.04%	0.02%	0.01%	0.01%
Combined	-0.22%	-0.12%	-0.13%	-0.13%

Notes: This table compares the "new" gains from CUSFTA from Table 4 which are calculated from formula (1) by taking differences using aggregate data (specification 1) to the "new" gains from CUSFTA calculated from formula (5) by running differences-in-differences regressions using industry-level data exploiting cross-industry variation in tariff cuts (specifications 2-4). All welfare effects are given in annualized terms, are weighted by their corresponding Sato-Vartia weights, and use the Oberfield and Raval (2014) elasticities. Panel D adjusts for nontraded and intermediate goods following formulas (4) and (7). The regressions results underlying the effects calculated for specifications 2-4 can be found in Tables 8-10.

TABLE 8: REGRESSION RESULTS UNDERLYING TABLE 7, SPECIFICATION 2

	"new" variety gains		**"new" productivity gains**		**overall "new" gains**	
	domestic	**foreign**	**domestic**	**foreign**	**domestic**	**foreign**
	$\frac{1}{\sigma_s - 1} ln \frac{M'_{jjs}}{M_{jjs}}$	$\frac{1}{\sigma_s - 1} ln \frac{M'_{ijs}}{M_{ijs}}$	$\frac{1}{\sigma_s - 1}\left(ln \frac{\bar{r}^c{}_{jjs}}{\bar{r}_{jjs}} - ln \frac{\bar{r}^{c\prime}{}_{jjs}}{\bar{r}'_{jjs}}\right)$	$\frac{1}{\sigma_s - 1}\left(ln \frac{\bar{r}^c{}_{ijs}}{\bar{r}_{ijs}} - ln \frac{\bar{r}^{c\prime}{}_{ijs}}{\bar{r}'_{ijs}}\right)$	$\frac{1}{\sigma_s - 1} ln \left(\frac{X^c{}_{jjs}/X_{jjs}}{X^{c\prime}{}_{jjs}/X'_{jjs}}\right)$	$\frac{1}{\sigma_s - 1} ln \left(\frac{X^c{}_{ijs}/X_{ijs}}{X^{c\prime}{}_{ijs}/X'_{ijs}}\right)$
$ln \frac{\tau'_s{}^{CAN}}{\tau_s{}^{CAN}}$	1.090***	-1.056**	-0.161	0.376	0.929***	-0.680**
	(0.260)	(0.381)	(0.213)	(0.318)	(0.222)	(0.316)
constant	-0.110	1.507***	-0.454***	-1.004***	-0.563***	0.503**
	(0.172)	(0.252)	(0.141)	(0.210)	(0.147)	(0.209)
observations	21	21	21	21	21	21
R^2	0.481	0.288	0.029	0.069	0.481	0.196

Notes: This table shows the regression results underlying the welfare effects reported in Table 7, specification 2. Standard errors are given in parentheses and ***, **, * indicate significance at the 1%, 5%, 10% level.

TABLE 9: REGRESSION RESULTS UNDERLYING TABLE 7, SPECIFICATION 3

	"new" variety gains		**"new" productivity gains**		**overall "new" gains**	
	domestic	**foreign**	**domestic**	**foreign**	**domestic**	**foreign**
	$\frac{1}{\sigma_s-1} ln \frac{M'_{jjs}}{M_{jjs}}$	$\frac{1}{\sigma_s-1} ln \frac{M'_{ijs}}{M_{ijs}}$	$\frac{1}{\sigma_s-1}\left(ln\frac{\bar{r}^c{}_{jjs}}{\bar{r}_{jjs}} - ln\frac{\bar{r}^{c\prime}{}_{jjs}}{\bar{r}'_{jjs}}\right)$	$\frac{1}{\sigma_s-1}\left(ln\frac{\bar{r}^c{}_{ijs}}{\bar{r}_{ijs}} - ln\frac{\bar{r}^{c\prime}{}_{ijs}}{\bar{r}'_{ijs}}\right)$	$\frac{1}{\sigma_s-1} ln\left(\frac{X^c{}_{jjs}/X_{jjs}}{X^{c\prime}{}_{jjs}/X'_{jjs}}\right)$	$\frac{1}{\sigma_s-1} ln\left(\frac{X^c{}_{ijs}/X_{ijs}}{X^{c\prime}{}_{ijs}/X'_{ijs}}\right)$
$ln\frac{\tau'_s{}^{CAN}}{\tau_s{}^{CAN}}$	0.993***	-1.285**	-0.74	0.501	0.919**	-0.784*
	(0.337)	(0.505)	(0.277)	(0.434)	(0.290)	(0.447)
$ln\frac{\tau'_s{}^{US}}{\tau_s{}^{US}}$	0.332	1.204	-0.288	-0.736	0.034	0.468
	(0.690)	(0.978)	(0.567)	(0.840)	(0.593)	(0.866)
$ln\frac{\tau'_s{}^{MEX}}{\tau_s{}^{MEX}}$		-0.056		0.041		-0.016
		(0.331)		(0.048)		(0.050)
constant	-0.076	1.076	-0.484***	-0.680	-0.560***	0.397
	(0.190)	(0.630)	(0.156)	(0.541)	(0.163)	(0.558)
observations	21	21	21	21	21	21
R^2	0.488	0.390	0.043	0.152	0.481	0.216

Notes: This table shows the regression results underlying the welfare effects reported in Table 7, specification 3. Standard errors are given in parentheses and ***, **, * indicate significance at the 1%, 5%, 10% level.

TABLE 10: REGRESSION RESULTS UNDERLYING TABLE 7, SPECIFICATION 4

	"new" variety gains		**"new" productivity gains**		**overall "new" gains**	
	domestic	**foreign**	**domestic**	**foreign**	**domestic**	**foreign**
	$\Delta\frac{1}{\sigma_s-1}ln\frac{M'_{jjs}}{M_{jjs}}$	$\frac{1}{\sigma_s-1}ln\frac{M'_{ijs}}{M_{ijs}}$	$\Delta\frac{1}{\sigma_s-1}\left(ln\frac{\bar{r}^c{}_{jjs}}{\bar{r}_{jjs}}-ln\frac{\bar{r}^{c'}{}_{jjs}}{\bar{r}'_{jjs}}\right)$	$\frac{1}{\sigma_s-1}\left(ln\frac{\bar{r}^c{}_{ijs}}{\bar{r}_{ijs}}-ln\frac{\bar{r}^{c'}{}_{ijs}}{\bar{r}'_{ijs}}\right)$	$\Delta\frac{1}{\sigma_s-1}ln\left(\frac{X^c{}_{jjs}/X_{jjs}}{X^{c'}{}_{jjs}/X'_{jjs}}\right)$	$\frac{1}{\sigma_s-1}ln\left(\frac{X^c{}_{ijs}/X_{ijs}}{X^{c'}{}_{ijs}/X'_{ijs}}\right)$
$ln\frac{\tau'_s{}^{CAN}}{\tau_s{}^{CAN}}$	0.669	-1.285**	0.455	0.501	1.123***	-0.784*
	(0.587)	(0.505)	(0.382)	(0.434)	(0.379)	(0.447)
$ln\frac{\tau'_s{}^{US}}{\tau_s{}^{US}}$	0.323	1.204	-0.717	-0.736	-0.395	0.468
	(1.201)	(0.978)	(0.780)	(0.840)	(0.776)	(0.866)
$ln\frac{\tau'_s{}^{MEX}}{\tau_s{}^{MEX}}$		-0.056		0.041		-0.016
		(0.331)		(0.048)		(0.050)
constant	-1.066***	1.076	0.607**	-0.680	-0.460**	0.397
	(0.331)	(0.630)	(0.215)	(0.541)	(0.214)	(0.558)
observations	21	21	21	21	21	21
R^2	0.136	0.390	0.076	0.152	0.392	0.216

Notes: This table shows the regression results underlying the welfare effects reported in Table 7, specification 4. Standard errors are given in parentheses and ***, **, * indicate significance at the 1%, 5%, 10% level.

Figure 1: Overall domestic "new" gains from CUSFTA

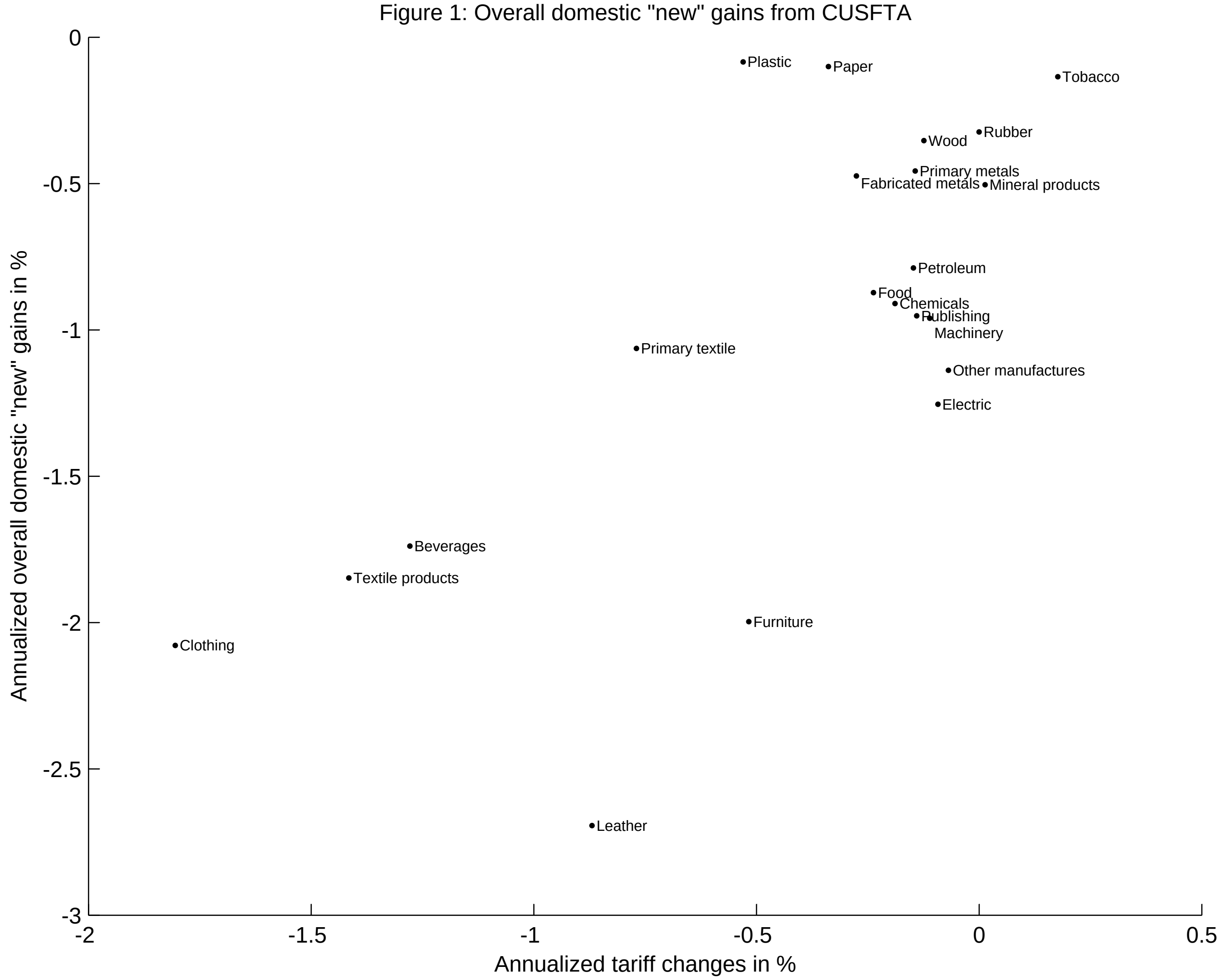

Figure 2: Domestic net variety gains from CUSFTA

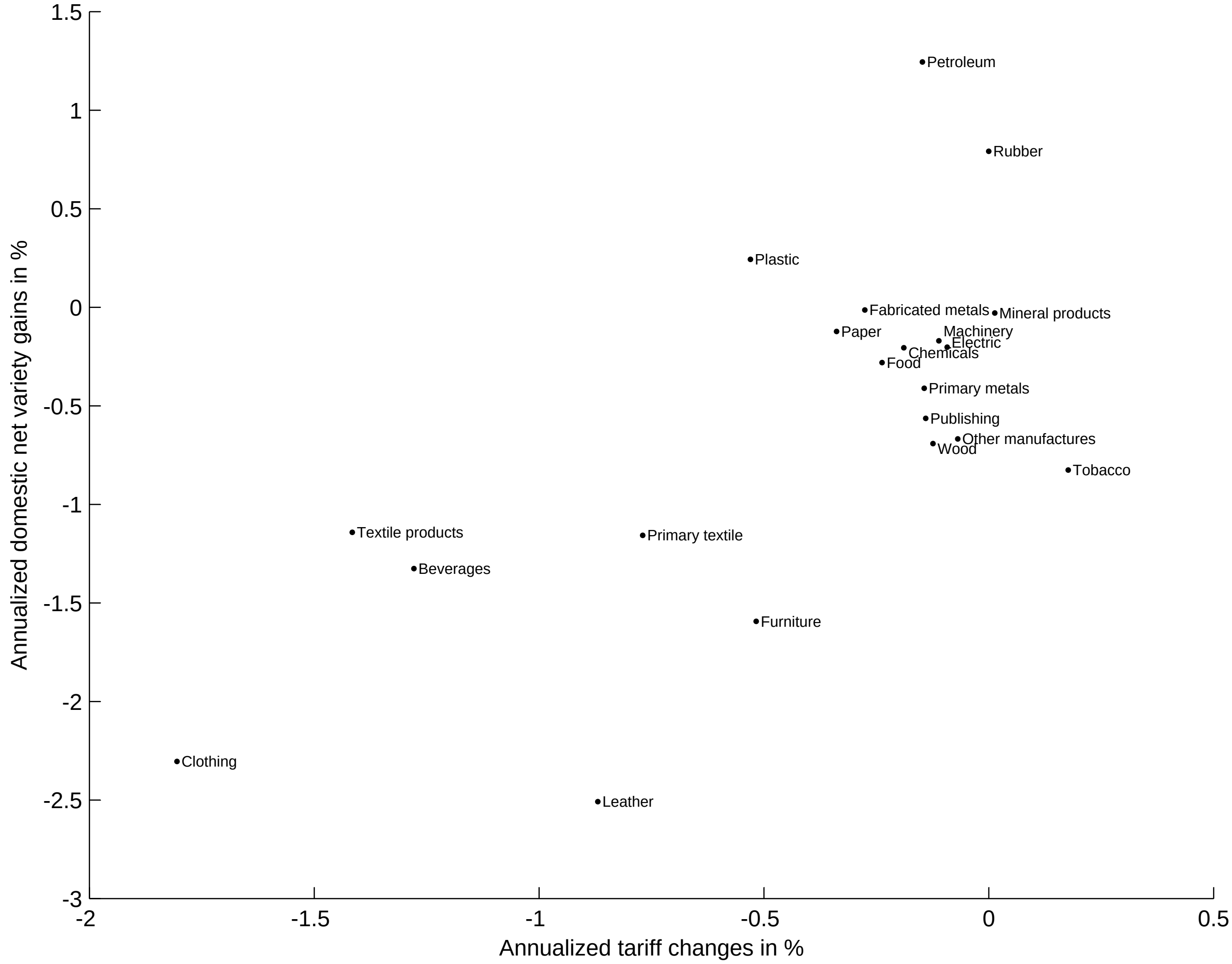

Figure 3: Domestic net productivity gains from CUSFTA

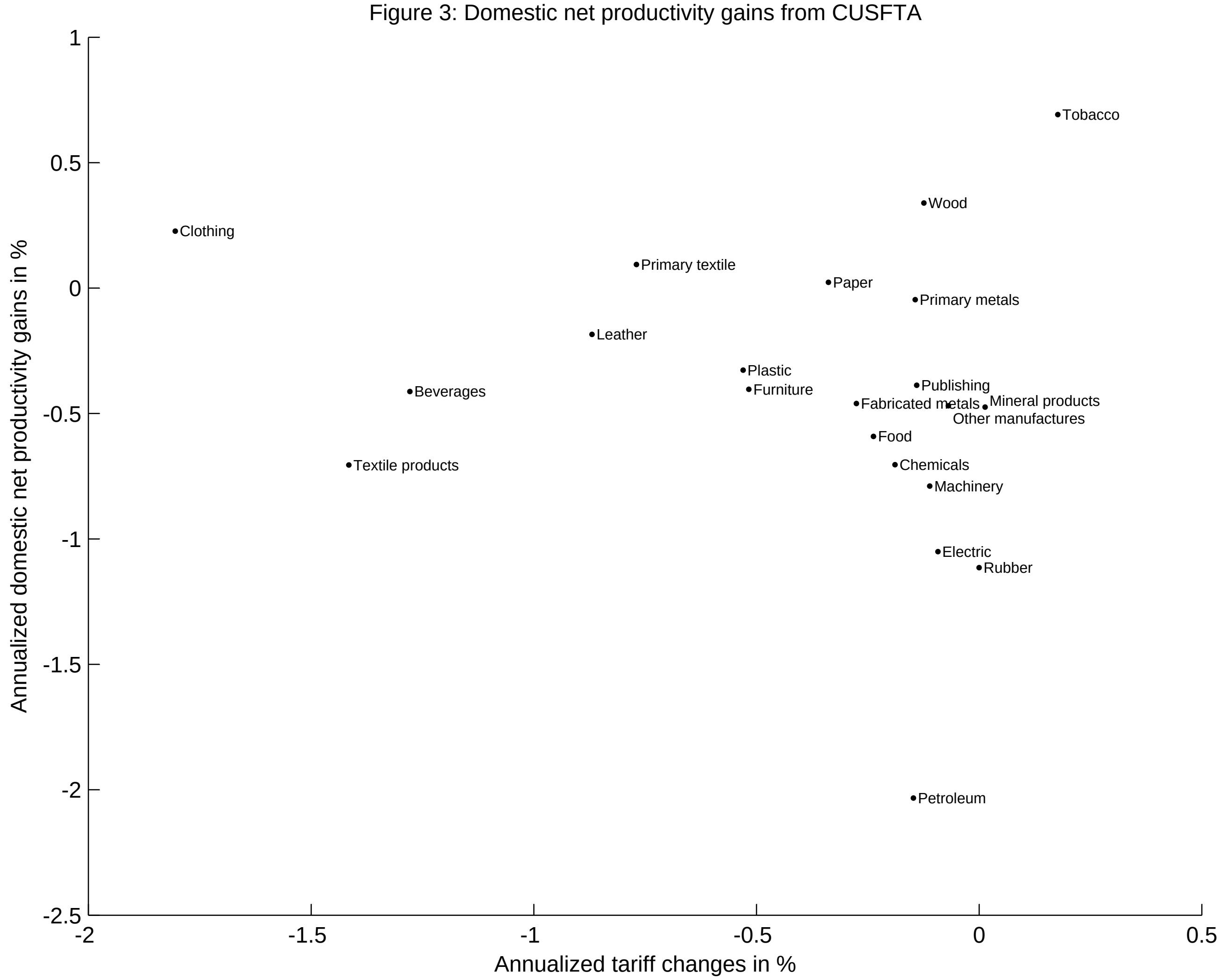

Figure 4: Overall foreign "new" gains from CUSFTA

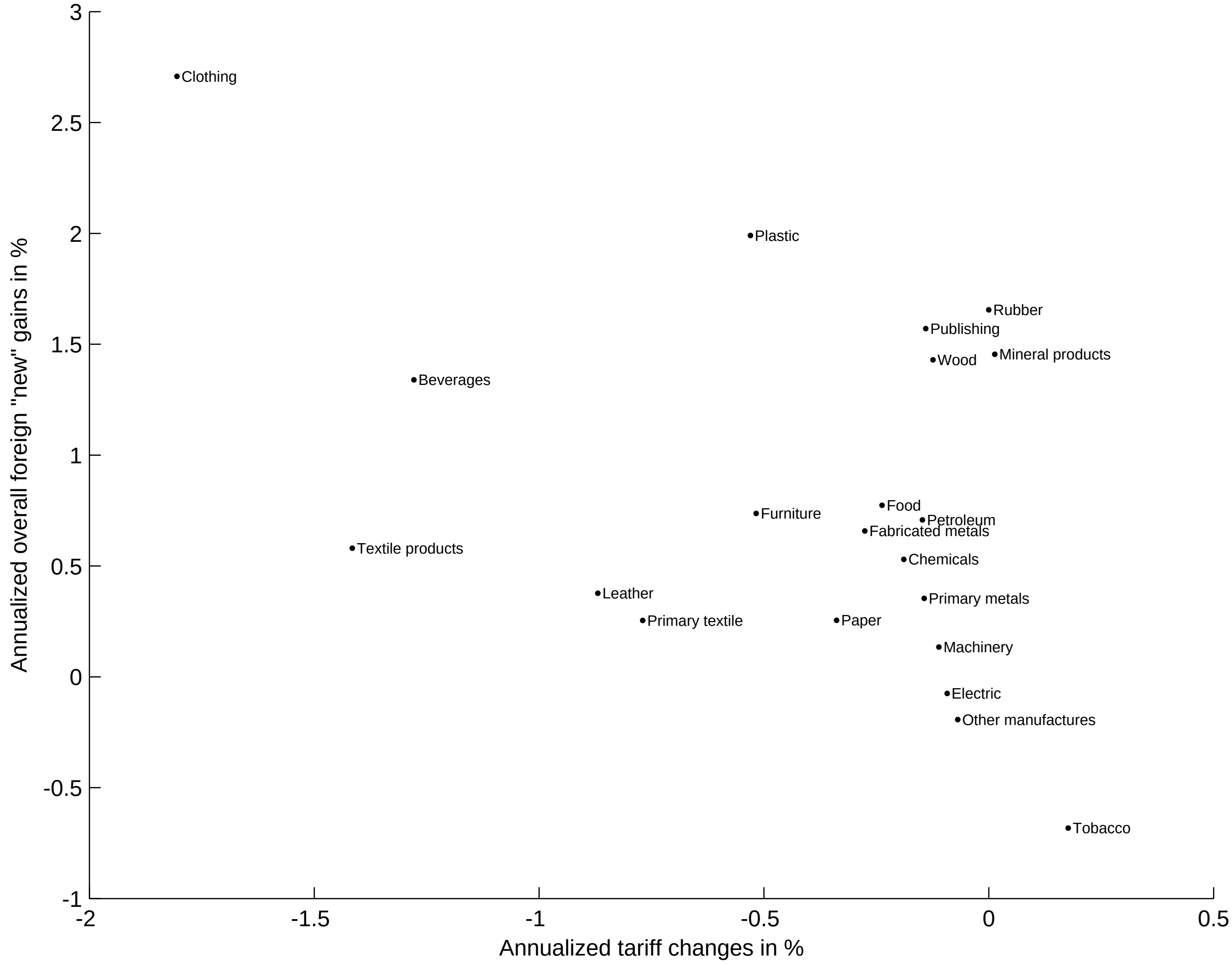

Figure 5: Foreign net variety gains from CUSFTA

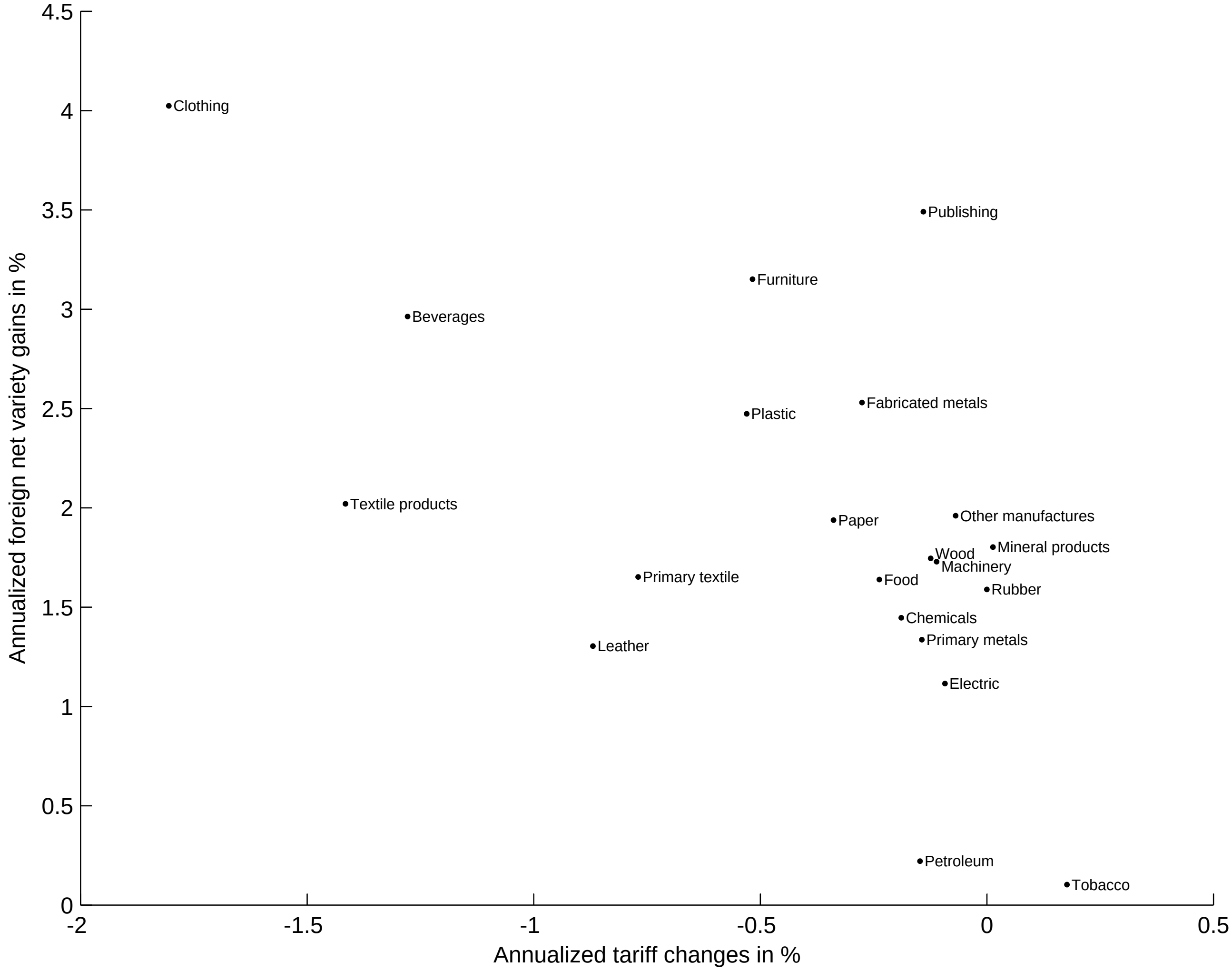

Figure 6: Foreign net productivity gains from CUSFTA

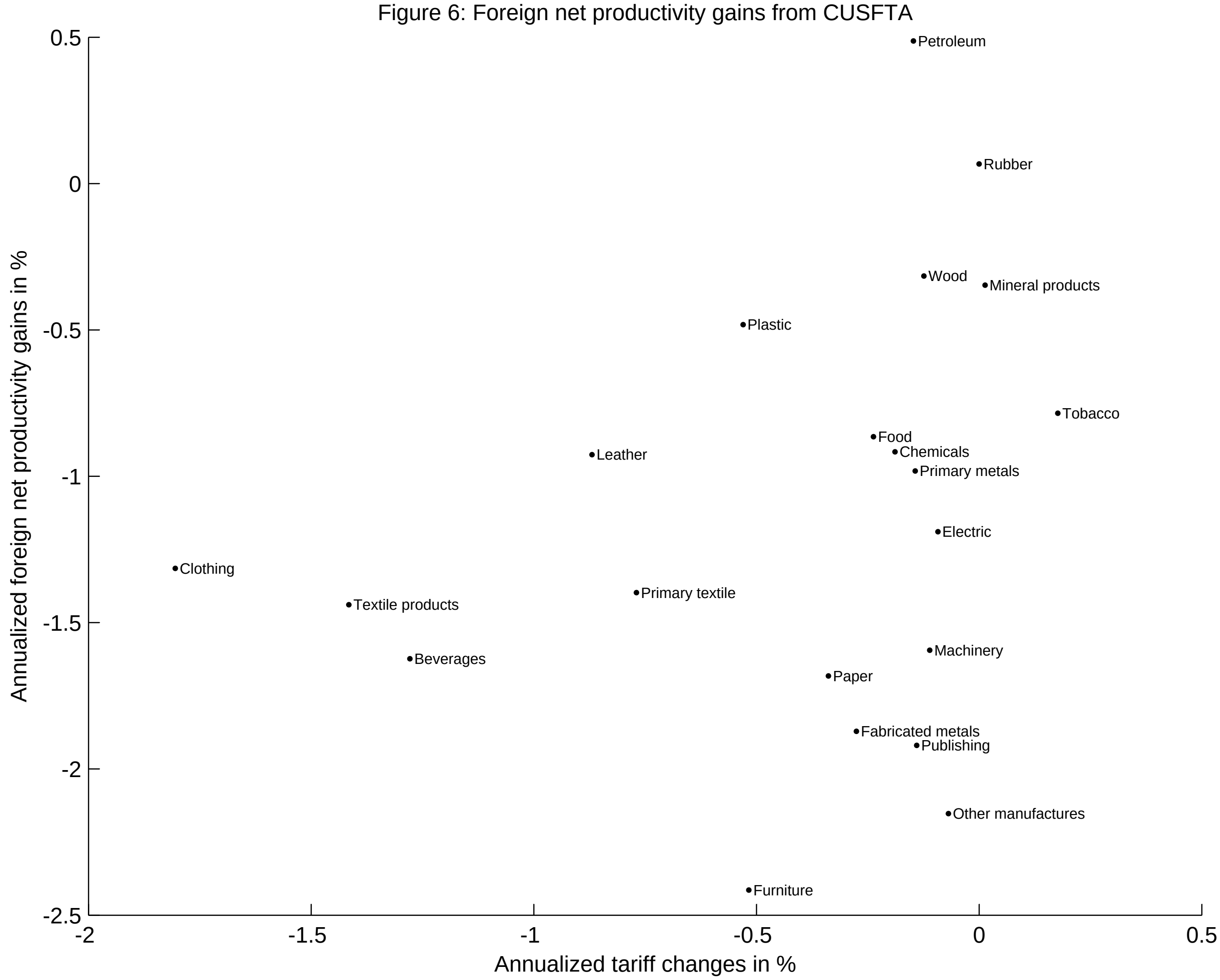

Figure 7: Overall domestic "new" gains from CUSFTA - exit only

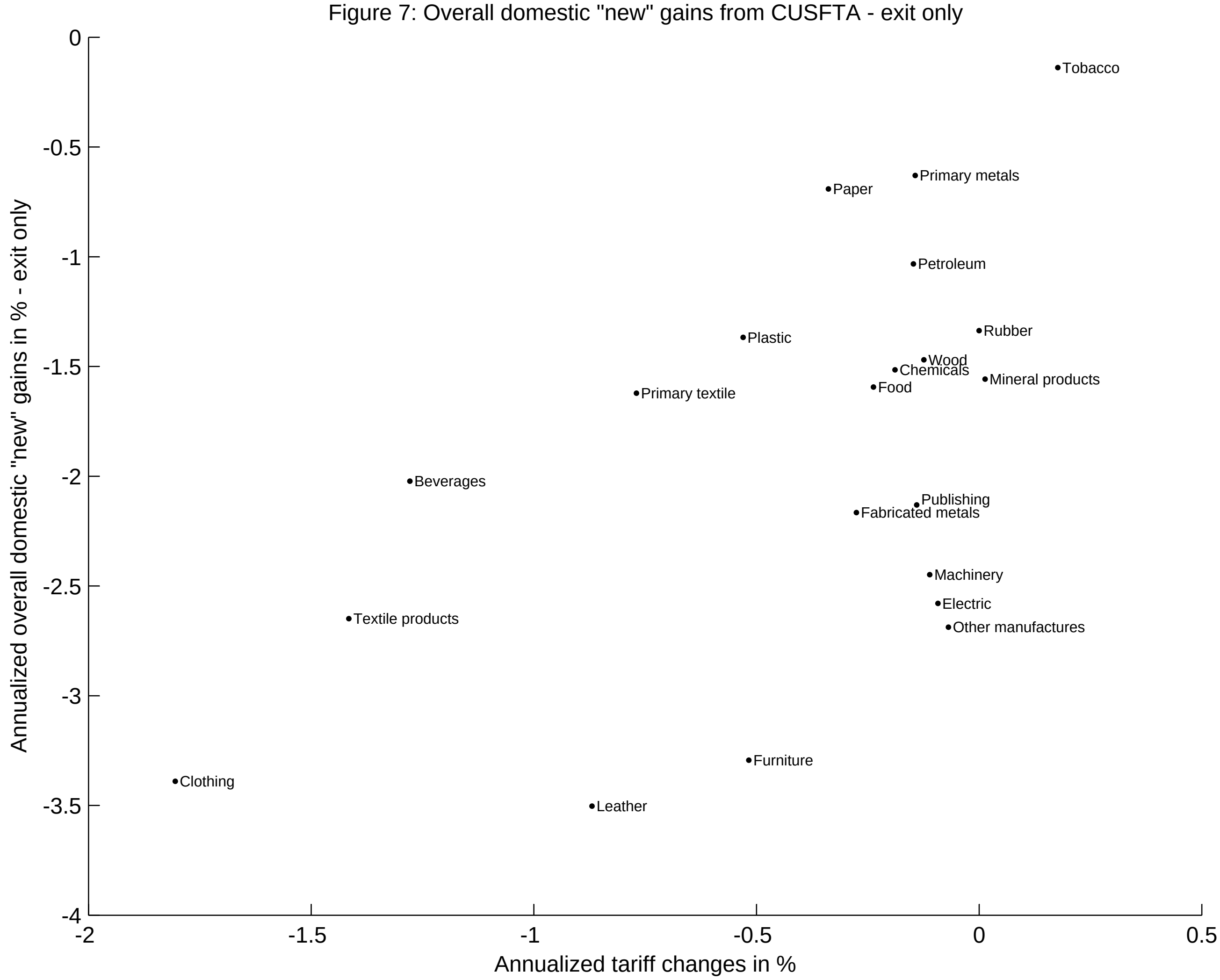

Figure 8: Overall domestic "new" gains from CUSFTA - entry only

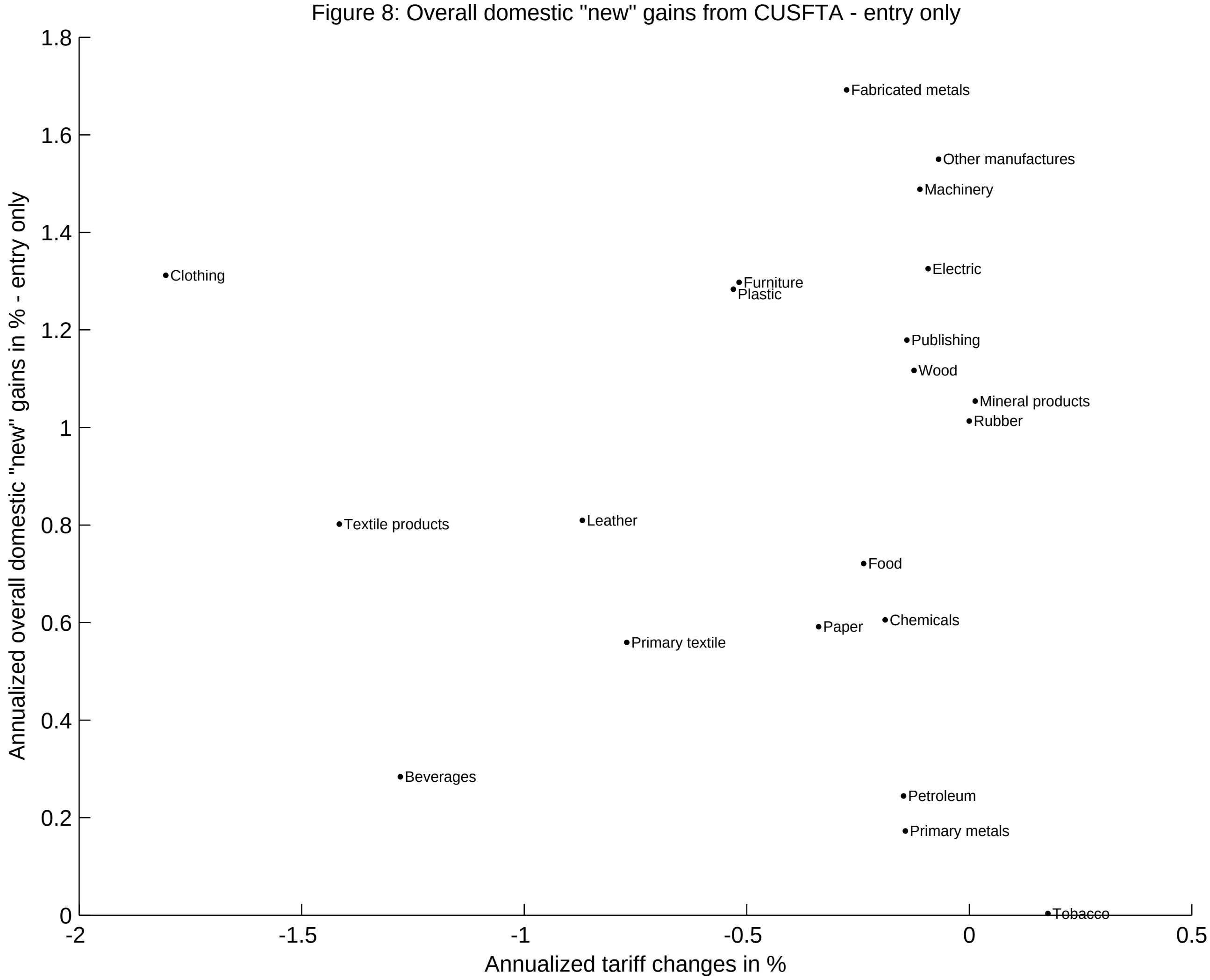

Figure 9: Domestic net variety gains from CUSFTA - exit only

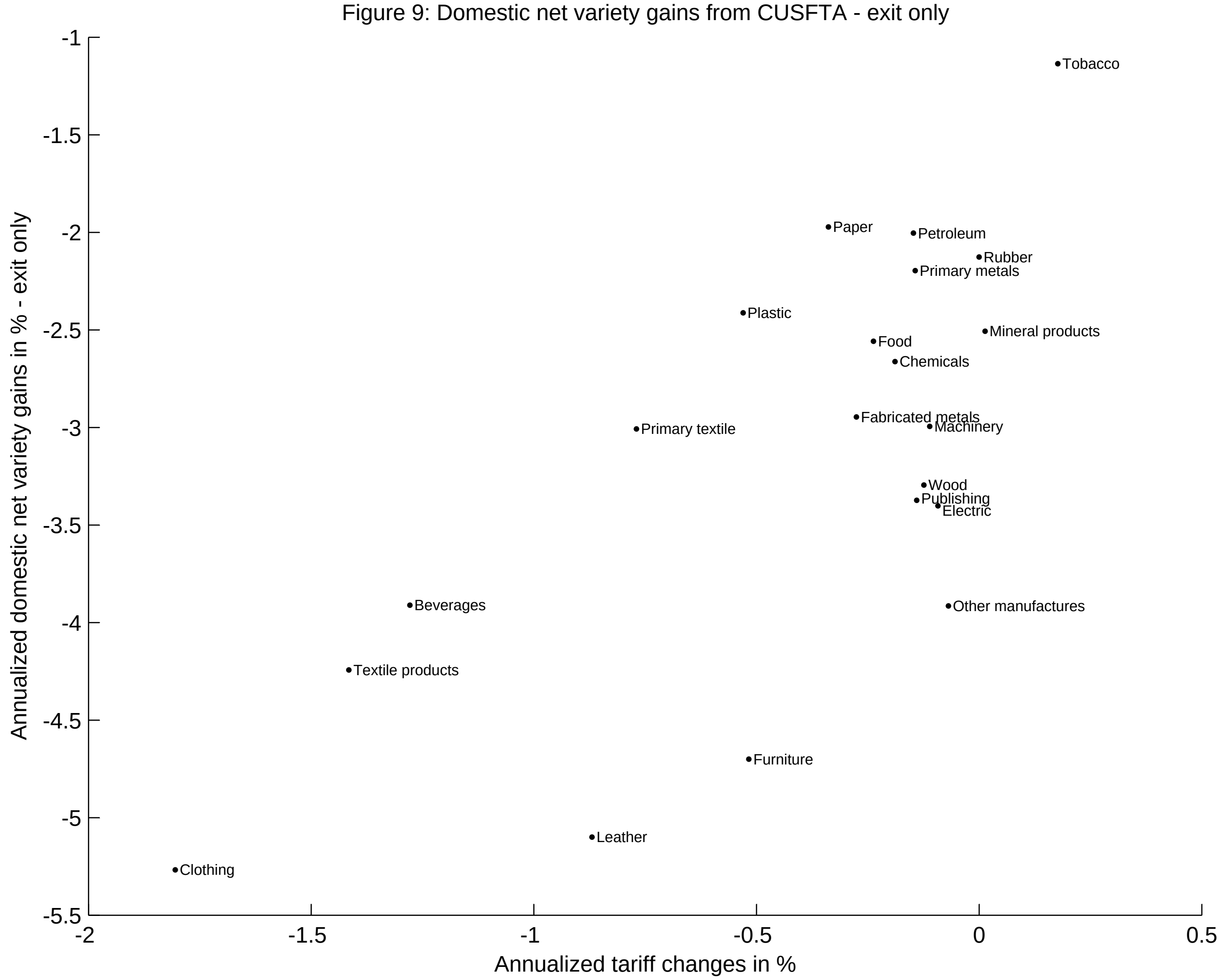

Figure 10: Domestic net productivity gains from CUSFTA - exit only