Merger Policy in a Quantitative Model of International Trade*

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Abstract

In a two-country international trade model with oligopolistic competition, we study the conditions on market structure and trade costs under which a merger policy designed to benefit domestic consumers is too tough or too lenient from the viewpoint of the foreign country. We calibrate the model to match industry-level data in the U.S. and Canada. Our results suggest that at present levels of trade costs, merger policy is too tough in the vast majority of sectors. We also quantify the resulting externalities and study the impact of different regimes of coordinating merger policies at varying levels of trade costs.

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1 Introduction

Because of cross-border demand and supply linkages, merger approval decisions of national antitrust authorities have important effects on other jurisdictions. This implies that for a given objective function (such as domestic consumer surplus, which is by and large current practice in the United States, the EU, and many other jurisdictions), conflicts between national authorities can arise. In particular, the efficiency gains induced by a merger might be sufficient to outweigh its anti-competitive effect in one country but not in another country, leading to diverging decisions of national merger authorities.

The past two decades have indeed seen a number of high-profile competition cases that illustrate this potential for conflict. Prominent examples include the proposed merger between the U.S.-based firms General Electric and Honeywell in 2001, the proposed merger of the South African platinum interests of Gencor and Lonrho in 1996, and the attempted joint acquisition of the British-based BOC Group by the French company Air Liquide and the U.S.-based firm Air Products in 2000. In the first two cases, the merger was cleared by the firms' domestic antitrust authority but blocked by the EU Commission; in the third case, the merger was cleared by the authorities in the EU, Canada and Australia, but effectively blocked by the U.S. Federal Trade Commission. Another example is the planned acquisition of the Italian company Metlac by the Dutch company Akzo Nobel, which was cleared by several European authorities but blocked by the UK Competition Commission in 2012.

In this paper, we propose a quantitative framework that can be used to understand the determinants of conflict between merger authorities, to analyze which types of conflicts are likely to arise in practice, and to provide a sense of their economic importance. We use these insights to derive implications for the coordination of national merger and trade policies.

In the first part of the paper, we develop a two-country model of international trade, where in each country there is a population of heterogeneous firms which produce a homogeneous good and compete in a Cournot fashion. While all firms produce in their home country, they can sell not only at home but also export to the other country. The presence of trade costs implies that the sets of firms active in the two countries will in general be different.

Consider a merger between two firms located in the same country and exporting to the other country. In both the home and foreign country, that merger has opposing effects on domestic consumer surplus: On the one hand, the merger gives rise to a market power effect (which is due to the internalization of competitive externalities post merger); on the other hand, the merger gives rise to an efficiency effect (which is due to merger-specific synergies). The resulting net effect depends on the characteristics of the merger, market conditions and trade costs. As the merger may raise consumer surplus in one country but reduce it in the other, the approval incentives of the national authorities are not fully aligned.

Whether merger control based on domestic consumer surplus is too tough or too lenient from the viewpoint of foreign consumers is shown to depend solely on an industry-level 'conflict statistic.' That conflict statistic for mergers among firms in a given industry and country is equal to the ratio of domestic to foreign pre-merger prices, adjusted for trade costs from the home to the foreign country. If the value of the statistic is larger than one, any pair of merger partners has more market power at home than abroad, no matter what their pre-merger marginal costs. This implies that if the merger benefits domestic consumers, it must also benefit foreign consumers, while the reverse is not true. In this case, merger control based on domestic consumer surplus is a *too-tough-for-thy-neighbor policy* as it involves blocking some mergers that would benefit consumers in the foreign country. Conversely, if the value of the statistic is smaller than one, merger control based on domestic consumer surplus is a *too-lenient-for-thy-neighbor policy* as it involves approving some mergers that hurt consumers in the foreign country. Generically, the value of the statistic is not equal to one, so there will always be one of these two types of conflict. We also show that any (unilateral or multilateral) reduction in trade costs reduces the value of the conflict statistic in both countries.

To say more about which types of conflict are likely to be relevant in practice, we calibrate our model in the second part of the paper. Since we are interested in merger policy and not in the impact of an isolated merger, such an exercise requires data that cover a broad range of industries. Ideally, one would like to define industries at a very disaggregated level, fine-tune our model to the details of each industry, and calibrate parameters using firm-level data. Unfortunately, such data are not available for a broad range of industries and even if they were, such an approach would be infeasible due to time and computational limitations. Instead, we use data for Canada and the U.S. at the 5-digit industry level, which is the most disaggregated level at which Canadian and U.S. industry definitions coincide. These data cover a broad range of tradable-goods industries (160 sectors) for the year 2002. To conduct this calibration exercise requires functional-form assumptions only on the demand function and the productivity distribution. Importantly, the industry-level conflict statistics can be computed without explicitly modeling mergers, and thus without taking a stance on potential merger-specific synergies and the merger formation process.

Our results suggest that at the present levels of trade costs, domestic merger policy is of the too-tough-for-thy-neighbor type in the vast majority of sectors in the U.S., and in all sectors in Canada. Intuitively, the presence of trade costs implies that, everything else being equal, firms have less market power abroad than at home. If both markets were equally competitive, this would result in the domestic consumer surplus standard being a too-tough-for-thy-neighbor policy. However, given that the U.S. market is more competitive in most sectors, there is a countervailing force for U.S. mergers that pushes towards a too-lenient-for-thy-neighbor policy.

The above results suggest that whether or not national authorities have effective veto rights over mergers involving foreign firms matters surprisingly little at current levels of trade costs.[1] When we reduce the trade cost parameters in our calibrated model, such veto rights become more valuable. Lower trade costs imply lower prices so that domestic authorities are more likely to approve domestic mergers. At the same time, lower trade costs result in domestic firms wielding more market power abroad and greater anticompetitive effects there. As trade costs fall, we thus see a switch from conflicts where the domestic authority wants to block a given domestic merger and the foreign authority wants to clear it, to conflicts in which the domestic authority wants to clear the merger and the foreign authority wants to block it. In our counterfactual simulations, this switch occurs for trade cost reductions that do not appear large from a historical perspective.

In the paper's third part, we quantify the importance of conflicts between authorities and analyze counterfactual scenarios for the international coordination of merger control. This requires modeling merger-specific synergies and an endogenous merger formation process. In the absence of a consensus in the existing literature on these issues, our modeling choices are mostly motivated by simplicity and computational feasibility. This part of the paper is therefore more exploratory in nature.

We consider two ways of coordinating national merger policies. We first quantify the impact of granting veto rights over foreign mergers. We find that this policy change only has minor effects, in line with our earlier finding that conflicts tend to be of the too-tough-for-thy-neighbor type. However, as trade costs fall from current levels, obtaining veto rights appears to become more valuable, especially for Canada as the less competitive market. Second, we introduce a North-American merger authority that maximizes the sum of Canadian and U.S. consumer surplus. As such a policy also addresses conflicts of the too-lenient-for-thy-neighbor type, it gives rise to much larger consumer surplus gains in North America. However, these

[1]There is considerable disagreement over the extent to which national authorities have effective veto rights over mergers involving only foreign firms. *De jure*, many countries have adopted the 'effects doctrine' in international competition law, according to which national authorities may assert jurisdiction over any foreign firm whose activity affects the domestic market (see, e.g., Griffin, 1999). In practice, however, the degree to which the effects doctrine is implemented varies substantially across countries, with most antitrust authorities not exercising the implied veto rights over foreign mergers. For example, we are not aware of any U.S. merger authorized by the U.S. but blocked by Canadian antitrust authorities.

gains come at the price of hurting Canadian consumers as the counterfactual merger authority gives little weight to the smaller Canadian market. At lower trade cost levels, the focus of a North American antitrust authority appears to shift from preventing domestic policies that are too tough to preventing policies that are too lenient, so that Canada benefits as well.

Our paper relates to several strands in the literature. First, we contribute to the theoretical literature on optimal horizontal merger policy (e.g., Williamson, 1968; Farrell and Shapiro, 1990; Nocke and Whinston, 2010, 2013). While we study the conditions under which different national merger authorities would come to different conclusions regarding the desirability of a given merger, this literature focuses almost exclusively on closed economy settings. An exception is Barros and Cabral (1994) who extend the analysis in Farrell and Shapiro (1990) on the 'external effect' of a merger (defined as the merger's effect on the sum of consumer surplus and non-participant firms' profits) by allowing some of the firms to be foreign-owned. They find that conflicts between national competition authorities are driven by international imbalances in consumption and production.[2] Focusing on a consumer surplus standard instead, we find that conflicts arise because both the efficiency and market power effects of a merger are likely to be different in the foreign and domestic markets.

Second, we contribute to a relatively small literature, surveyed by Breinlich, Nocke, and Schutz (2017), that looks at the interaction of merger and trade policies (e.g., Horn and Levinsohn, 2001; Rysman, 2001; De Stefano and Rysman, 2010). In this literature, merger policy is akin to industrial policy. For example, in Horn and Levinsohn (2001) and Rysman (2001), countries directly set the number of firms. By contrast, we model mergers explicitly. Moreover, we provide a richer and more general framework, and a quantitative analysis.

We also contribute to the international trade literature concerned with the causes and consequences of domestic and cross-border mergers (e.g., Neary, 2007; Nocke and Yeaple, 2007, 2008; di Giovanni, 2005; Breinlich, 2008) and with strategic aspects of firm behavior and trade policy in open economy settings (e.g., Brander and Spencer, 1985; Brander, 1995; Bagwell, Bown, and Staiger, 2016). While competition policy is not the focus of this literature, we use comparable modeling frameworks. Our calibration techniques should be helpful with a quantification of some of the insights from this earlier literature.

The rest of this paper is organized as follows. In Section 2, we describe the model. In Section 3, we provide an equilibrium analysis, characterizing the types of conflict that can arise between national antitrust authorities. In Section 4, we calibrate the model on industry-

[2]Head and Ries (1997) obtain similar results focusing on the aggregate surplus effects of mergers. Neven and Röller (2000, 2003) study the determinants of conflict between antitrust authorities in a model in which national authorities follow mechanical rules based on market definition and market dominance tests.

level data from the U.S. and Canada, and analyze the prevalent types of conflicts at varying levels of trade costs. In Section 5, we extend the calibration to quantify the effects from the international coordination of merger control under different scenarios. Finally, Section 6 concludes. Omitted proofs are in the Appendix.

2 The Baseline Model

We consider a setting with two possibly asymmetric countries ($i, j = 1, 2$), S manufacturing sectors and an outside sector. Country i is endowed with L^i units of labor. Labor markets are perfectly competitive; there is perfect labor mobility across sectors and no labor mobility across countries. In country i, the representative consumer's utility function is given by:

$$U^i(Q_0^i, \boldsymbol{Q}^i) = Q_0^i + \sum_{s=1}^{S} u_s^i(Q_s^i),$$

where Q_0^i is the consumption of the outside good, u_s^i is a sub-utility function, and Q_s^i is the consumption of manufacturing good s. The budget constraint is: $P_0^i Q_0^i + \sum_{s=1}^{S} P_s^i Q_s^i \leq I^i$, where P_0^i is the price of the outside good and P_s^i the price of good s in country i. We assume that parameter values are such that consumer income I^i, the sum of labor income $w^i L^i$ and profits, is sufficiently large so that a positive quantity of the outside good is consumed. Given our focus on consumer surplus and the absence of income effects, the ownership structure of domestic and foreign firms is irrelevant for the subsequent analysis.

The outside good is produced under perfect competition using a constant-returns-to-scale technology with labor as the only factor of production. One unit of labor generates α^i units of output. We assume that the outside good is freely traded, so that its price is the same in both countries. We also assume parameter values such that the outside sector produces positive amounts in both countries. We further use the price of the outside good as the *numéraire* ($P_0^1 = P_0^2 = 1$). This pins down the wage rate in country i at $w^i = \alpha^i$.[3] The inverse demand function for good s in country i is therefore given by $P_s^i\left(Q_s^i\right) = \max\left\{u_s^{i\prime}\left(Q_s^i\right), 0\right\}$.

In each country i, there is a set $\mathcal{N}_s^i$ of firms manufacturing good s. Each firm $k \in \mathcal{N}_s^i$ produces only in its home country i, so that $\mathcal{N}_s^1 \cap \mathcal{N}_s^2 = \emptyset$, but can sell at home and also

[3] The assumption that the outside good is freely traded and produced under constant returns to scale is made for tractability: As the equilibrium wage rate is pinned down by the labor productivity in this sector, a separate modeling of the labor market is not required. This is a common assumption in the international trade literature (see, e.g., Melitz and Ottaviano, 2008). Trade papers that have allowed for wage responses have typically found that they are quantitatively unimportant (e.g., Breinlich and Cuñat, 2016).

export to the foreign country j. Exports are subject to iceberg-type trade costs: For one unit of good s to arrive in country j, a firm located in country i has to ship τ_s^{ij} units of the good, where $\tau_s^{ij} = 1$ if $i = j$.

In each country and manufacturing sector, firms compete *à la* Cournot, with perfectly segmented markets. Manufacturing firms combine labor and the outside good (as an intermediate input), using a constant-returns-to-scale technology. Let c_k denote the firm's constant marginal cost of *producing* good s. The firm's marginal cost of *selling* the good in country j is $c_k^j \equiv \tau_s^{ij} c_k$. Let $N_s^i \equiv |\mathcal{N}_s^i|$ denote the number of manufacturing firms in sector s that are located in country i. Denoting q_k^j firm k's output in country j, we say that firm k is *active* in country j and sector s if $q_k^j > 0$ in equilibrium.

As is well known (see, e.g., Vives, 2000), the following standard assumption on demand implies that there exists a unique and stable Nash equilibrium in each sector and country:

Assumption 1. *For any country i and sector s, $\lim_{Q\to\infty} P_s^i(Q) = 0$ and $P_s^i(Q) > \min_{k\in\mathcal{N}_s^i} c_k$ for $Q > 0$ sufficiently small. Moreover, for any aggregate output $Q > 0$ such that $P_s^i(Q) > 0$, $P_s^{i\prime}(Q) < 0$ and $P_s^{i\prime}(Q) + QP_s^{i\prime\prime}(Q) < 0$.*

Lemma 1. *There exists a unique Nash equilibrium. The Cournot equilibrium price in each country i and sector s, P_s^{i*}, is weakly increasing in firm k's marginal cost of selling in country i, c_k^i, and strictly so if the firm is active in that country.*

In equilibrium, firm $k \in \mathcal{N}_s^j$ is not active in country i if and only if $\tau_s^{ji} c_k \geq P_s^{i*}$. The equilibrium may thus have the feature that some firms export while others do not.

3 Domestic and Foreign Price Effects of Mergers

In this section, we study the effects of a merger between two domestic firms on domestic and foreign prices and, thus, on domestic and foreign consumer surplus. The focus on consumer surplus is in line with antitrust laws and practice in the U.S., the EU and many other jurisdictions.[4] We provide the conditions under which different types of conflicts between national authorities arise.

Consider merger $M_s = \{k, l\}$ between firms $k \in \mathcal{N}_s^j$ and $l \in \mathcal{N}_s^j$, both of which produce good s in country j. Dropping the subscript s from now on, let $\bar{c}_M$ denote the merged entity's post-merger marginal cost. Denote the Cournot equilibrium price in country i before the

[4]For instance, Whinston (2007) summarizes the perceived wisdom on merger authorities' objective function as follows: "[...] enforcement practice in most countries (including the U.S. and the E.U.) is closest to a consumer surplus standard." See also the U.S. and EU Horizontal Merger Guidelines.

merger by P^{i*}, and after the merger by $\overline{P}^{i*}$. Since products are homogeneous, the consumer surplus (CS) effect of the merger in country i has the same sign as $P^{i*} - \overline{P}^{i*}$. We say that merger M is *CS-neutral* in country i if $\overline{P}^{i*} = P^{i*}$, *CS-decreasing* if $\overline{P}^{i*} > P^{i*}$, *CS-increasing* if $\overline{P}^{i*} < P^{i*}$, *CS-nonincreasing* if $\overline{P}^{i*} \geq P^{i*}$, and *CS-nondecreasing* if $\overline{P}^{i*} \leq P^{i*}$.

From Lemma 1 it follows that the CS-effect of a merger is the larger (i.e., the more positive or the less negative), the lower is the merged firm's post-merger marginal cost. The following lemma, which is an extension of the results in Farrell and Shapiro (1990) to a two-country world, characterizes the sign of the effect of merger M on consumer surplus in country i:

Lemma 2. *Consider merger $M = \{k, l\}$ between firms $k \in \mathcal{N}^j$ and $l \in \mathcal{N}^j$, both of which are located in country j, and let*

$$\mu^i = \max\left(\frac{P^{i*}}{\tau^{ji}} - \overline{c}_M, 0\right) - \max\left(\frac{P^{i*}}{\tau^{ji}} - c_k, 0\right) - \max\left(\frac{P^{i*}}{\tau^{ji}} - c_l, 0\right).$$

The merger is CS-increasing in country i if $\mu^i > 0$, CS-neutral if $\mu^i = 0$, and CS-decreasing if $\mu^i < 0$. Moreover, if both merger partners are active in country i pre-merger, then there exists a unique cutoff $\widehat{c}^i_M$ such that the merger is CS-neutral in country i if $\overline{c}_M = \widehat{c}^i_M$, CS-decreasing if $\overline{c}_M > \widehat{c}^i_M$ and CS-increasing if $\overline{c}_M < \widehat{c}^i_M$.[5] *This cutoff is given by*

$$\widehat{c}^i_M \equiv c_k + c_l - \frac{P^{i*}}{\tau^{ji}}.$$

For the merger to be CS-increasing, the profit margin of the merged firm evaluated at the pre-merger price must exceed the sum of the pre-merger profit margins of the merger partners. A CS-increasing merger must therefore involve synergies: $\overline{c}_M < \min(c_k, c_l)$. When both merger partners are active pre-merger, Lemma 2 shows that the threshold value of post-merger marginal cost, $\widehat{c}^i_M$, below which merger M is CS-increasing in country i, is decreasing in the pre-merger equilibrium price in country i. Intuitively, a reduction in the pre-merger equilibrium price does not affect the efficiency effect of the merger but reduces its market power effect as each merger partner's pre-merger output is decreasing in the pre-merger price.

Suppose that the merger partners are active pre-merger both at home and abroad. Then, the domestic and foreign antitrust authorities would both want to block the merger if $\overline{c}_M > \max\{\widehat{c}^1_M, \widehat{c}^2_M\}$ and approve it if $\overline{c}_M < \min\{\widehat{c}^1_M, \widehat{c}^2_M\}$. If $\min\{\widehat{c}^1_M, \widehat{c}^2_M\} < \overline{c}_M < \max\{\widehat{c}^1_M, \widehat{c}^2_M\}$, however, the interests of the two authorities conflict with each other as the consumers in one country would be better off with the merger and the consumers in the other country

[5] Lemma 1 in Nocke and Whinston (2010) implies that if the merger is CS-nondecreasing in country i, then it raises the merger partners' joint profit from selling in that country. See Appendix A.2.

without. Generically, $\widehat{c}_M^1 \neq \widehat{c}_M^2$, implying that there is always the potential of such conflicts. The exact nature of the conflict depends on whether merger M can be blocked not only by the domestic (here, country j's) authority but also by the foreign (here, country i's, $i \neq j$) authority—see the discussion of veto rights in Footnote 1.

We propose the following taxonomy of conflicts which accommodates both a 'veto-rights' case and a 'no-veto-rights' case. For country-j mergers, country j's CS-standard is a *too-tough-for-thy-neighbor policy* if there exists a country-j merger that is CS-decreasing in country j and CS-increasing in country i, and if every country-j merger that is CS-nondecreasing in country j is also CS-nondecreasing in country i. By contrast, if there exists a country-j merger that is CS-nondecreasing in country j and CS-decreasing in country i, and if every country-j merger that is CS-decreasing in country j is also CS-decreasing in country i, then country j's CS-standard is a *too-lenient-for-thy-neighbor policy* in the no-veto-rights case, and country i's CS-standard is a *too-tough-for-thy-neighbor policy on foreign mergers* in the veto-rights case. In the following, we state our results within the 'no-veto-rights' framework to ease the exposition.

The following proposition shows that, generically, country j's CS-standard is either a too-tough-for-thy-neighbor policy or a too-lenient-for-thy-neighbor policy:

Proposition 1. *Suppose that at least two country-j firms are active at home and abroad. The domestic CS-standard for merger approval in the home country j is a too-tough-for-thy-neighbor policy if $\rho^{j*} > 1$ and a too-lenient-for-thy-neighbor policy if $\rho^{j*} < 1$, where*

$$\rho^{j*} \equiv \tau^{ji} \frac{P^{j*}}{P^{i*}}, \ i \neq j.$$

Proposition 1 shows that the potential for conflict in merger policy depends solely on a market-level "sufficient statistic," ρ^{j*}, which summarizes the relative competitiveness of the two markets, adjusting for trade costs faced by the merging firms. We call ρ^{j*} the "conflict statistic" for country-j mergers. Intuitively, if trade costs are high ($\tau^{ji} > 1$) or if the foreign market is more competitive than the domestic market ($P^{i*} < P^{j*}$), so that $\rho^{j*} > 1$, domestic firms tend to have lower market shares abroad than they do at home. The market power effect of the merger is therefore more likely to dominate the efficiency effect at home than abroad, and the nature of the potential conflict on domestic mergers tends to be of the too-tough-for-thy-neighbor type.

These conflict statistics involve endogenous prices. This raises the question: Under what conditions on primitives is one type more likely to arise than the other? In the simple case where the two countries are identical, $\tau^{12} = \tau^{21} \equiv \tau$ and $P^{1*} = P^{2*}$, both conflict statistics are equal to τ, and the domestic CS-standard for merger approval is a too-tough-for-thy-neighbor policy if $\tau > 1$, and a too-lenient-for-thy-neighbor policy if $\tau < 1$. To the extent that one would expect the iceberg-type trade cost τ to be larger than one, this suggests that conflict is likely to be of the too-tough-for-thy-neighbor type when countries are similar.

The following proposition shows that the general idea that conflict is more likely to be of the too-tough-for-thy-neighbor type when trade costs are high extends to the case of asymmetric countries:[6]

Proposition 2. *An increase in the trade cost from country j to country $i \neq j$, τ^{ji}, induces an increase in the conflict statistics for mergers in both countries, ρ^{1^*} and ρ^{2*}.*

More than two countries. None of our results relies on the restriction to two countries: Lemma 2 and Propositions 1 and 2 would hold for an arbitrary number of countries. Whether a merger between two firms producing in country i is CS-increasing or CS-decreasing in country j depends only on the pre-merger price in country j, P^{j*}, and on the merger partners' marginal costs of selling in country j, both pre- and post-merger. Changes in the openness of country j to imports from third countries affect the sign of the merger's consumer surplus effect only through their impact on P^{j*}. The definition of our conflict statistic ρ^{i*} thus remains unchanged.

Additive trade costs. As is standard in the international trade literature, we have assumed iceberg-type trade costs. In recent work, Irarrazabal, Moxnes, and Opromolla (2015) point out that important parts of trade costs are best thought of as being additive rather than multiplicative (e.g., due to freight rates being quoted per unit). Under additive trade costs, the cutoff type defined in Lemma 2 can easily be shown to be equal to $\widehat{c}^i_M \equiv c_k + c_l + \tau^{ji} - P^{i*}$. The conflict statistic ρ^{j*} can therefore be redefined as $\rho^{j*} = P^{j^*} - P^{i^*} + \tau^{ji}$. In this case, country j is too tough (resp., too lenient) if $\rho^{j*} > 0$ (resp., $\rho^{j*} < 0$). The proof of Proposition 2 can be adapted to show that ρ^{j*} is increasing in both τ^{ij} and τ^{ji}.

4 Model Calibration without Mergers

In this section, we calibrate the model to sector-level data from the U.S. and Canada for 2002. The goal of this first set of calibrations is to evaluate which types of conflicts are likely to be

[6]In the Online Appendix I, we also study the impact of demand and supply conditions on our conflict statistics.

relevant in practice, and how this changes as trade costs evolve. A calibration approach is helpful in this context because it imposes some discipline on the parameter values governing the prevalence of the two types of conflict. It allows us to obtain model-consistent estimates of bilateral trade costs and permits the analysis of counterfactual changes in these costs.[7]

Such a cross-industry calibration gives rise to a number of issues. First, while we work at a relatively disaggregated level (160 manufacturing industries) this approach might still group firms that do not compete very much against each other.[8] Second, we will use the same demand system and competition model for all our sectors, albeit with parameters calibrated separately for each industry. As discussed in the introduction, these simplifications are necessary to make the analysis feasible. In Section 4.4, we show that our main results are robust to changes in the data and the modeling framework.

4.1 Model Operationalization: Preferences and Technologies

The sub-utility $u_s^i(\cdot)$ is now given by $u_s^i(Q_s^i) = a_s^i Q_s^i - \frac{1}{2} b_s^i \left(Q_s^i\right)^2$, which induces the linear inverse demand function $P_s^i\left(Q_s^i\right) = \max\left(a_s^i - b_s^i Q_s^i, 0\right)$. (We solve the Cournot competition game with linear demand in Online Appendix II.) The production function of firm k in sector s and country i is given by

$$q_k = \frac{1}{(\eta_s^i)^{\eta_s^i}(1-\eta_s^i)^{1-\eta_s^i}} z_k l_k^{\eta_s^i} q_{0,k}^{1-\eta_s^i},$$

where l_k and $q_{0,k}$ denote firm k's consumption of labor and intermediate goods, η_s^i is the labor input share in sector s and country i, and z_k is the productivity of firm k. Firm k's productivity in sector s and country i, z_k, is drawn from a Pareto distribution with scale parameter x_s^i and shape parameter ζ_s^i.[9] The implied marginal cost of firm k is given by

$$c_k = \frac{1}{z_k}(w^i)^{\eta_s^i}(P_0^i)^{(1-\eta_s^i)} = \frac{1}{z_k}(\alpha^i)^{\eta_s^i},$$

[7] Note that our conflict statistic, ρ^{j*}, depends on prices and trade costs only. While the former are in principle observable, the latter are not. This is because we require a wide definition of trade costs which includes any factor making selling abroad more costly than at home. Backing out trade costs as a residual from a theoretical model is the preferred way of doing this in the trade literature (e.g., Anderson and van Wincoop, 2004). When we vary trade costs, we also need to compute counterfactual price changes which will depend on all model parameters, requiring a full-scale calibration in the first place.

[8] An example of a problematic sector is cement manufacturing (NAICS 32731), which, due to high transport costs, is comprised of many small geographical submarkets. Other sectors (e.g., breakfast cereal manufacturing, NAICS 31123) seem to be more in line with market definition in antitrust.

[9] The assumption of Pareto-distributed productivities is fairly standard in the recent trade literature. Examples include Helpman, Melitz, and Yeaple (2004), Chaney (2008), Melitz and Ottaviano (2008), Eaton, Kortum, and Kramarz (2011), and Mayer, Melitz, and Ottaviano (2014).

where the last step follows from our choice of the outside good as *numéraire* and the resulting wage rate of $w^i = \alpha^i$.[10]

4.2 Calibration

Parameters to be calibrated. We calibrate our model by matching key features of U.S. and Canadian data at the industry level. From now on, we relabel country 1 as the U.S. and country 2 as Canada. We calibrate our model separately for each sector. The calibration requires, for each sector, parameter values for a^{US} and a^{CAN} (the intercepts of the inverse demand functions), b^{US} and b^{CAN} (the slopes of the inverse demand functions), N^{US} and N^{CAN} (the numbers of potentially active firms), $\tau^{US,CAN}$ and $\tau^{CAN,US}$ (the trade costs), x^{US} and x^{CAN} (the scale parameters of the productivity distributions), ζ^{US} and ζ^{CAN} (the shape parameters of the productivity distributions), and η^{US} and η^{CAN} (the labor shares). We also require parameter values for α^{US} and α^{CAN} (the productivities of the outside sectors).

We choose units of the numéraire so that $\alpha^{US} = 1$, and set α^{CAN} equal to the ratio of Canadian to U.S. wages in the data. Consistent with our Cobb-Douglas specification of production functions and our assumption of perfectly competitive labor and outside good markets, η^{US} and η^{CAN} are set equal to the ratio of the wage bill to total costs in each sector. In every sector, we use the normalization $a^{US} = 25$, which also amounts to a choice of units.

We set N^{US} and N^{CAN} equal to the number of firms in each sector, which we observe in the data. Not all of these firms will, however, end up being active due to homogeneous-goods Cournot competition with heterogeneous firms. In Section 4.4, we address this issue by introducing a competitive fringe of price-taking firms, and by analyzing a differentiated-goods Bertrand model where all firms are active.

We are left with a nine-dimensional vector of parameters to calibrate in every sector:

$$\Gamma = \left(a^{CAN}, b^{US}, b^{CAN}, \tau^{US,CAN}, \tau^{CAN,US}, x^{US}, x^{CAN}, \zeta^{US}, \zeta^{CAN}\right).$$

The value of Γ is chosen so as to match the following nine empirical moments in each sector: the ratio of U.S. to Canadian prices, domestic sales, the value of U.S. and Canadian bilateral exports, production-based Herfindahl-Hirschman concentration indices (HHI), and total costs in both countries. The theoretical counterparts to those empirical moments

[10] The substantial assumptions we are making are that there are constant returns to scale and the inverse of unit costs are Pareto distributed. Since a Pareto distribution is scale-free (in that a left-truncation of a Pareto distribution does not affect its shape), mis-calibrating α or η (or misspecifying the production function altogether) only affects the resulting value of the scale parameter x in the calibration, while leaving other parameters in the calibration as well as the calibrated distribution of unit costs unchanged.

are: $\mathbb{E}(P^{US})/\mathbb{E}(P^{CAN})$, $\mathbb{E}\left(\sum_{k\in\mathcal{N}^i} P^i q_k^i\right)$, $\mathbb{E}\left(\sum_{k\in\mathcal{N}^i} P^{-i} q_k^{-i}\right)$, $\mathbb{E}\left(\frac{\sum_{k\in\mathcal{N}^i}\left(P^i q_k^i+P^{-i}q_k^{-i}\right)^2}{\left(\sum_{k\in\mathcal{N}^i} P^i q_k^i+P^{-i}q_k^{-i}\right)^2}\right)$, and $\mathbb{E}\left(\sum_{k\in\mathcal{N}^i} c_k\left(q_k^i+q_k^{-i}\right)\right)$ for $i\in\{US, CAN\}$, where q_k^i and P^i are equilibrium quantities and prices for a given realization of the productivity vector, and $\mathbb{E}(\cdot)$ denotes the expectation operator over productivity realizations. Note that the number of elements in Γ equals the number of empirical moments, so that the parameters are exactly identified.

Data sources. Data on U.S. and Canadian industry-level sales, total costs, labor cost shares, number of firms and Herfindahl indices are from the U.S. Census Bureau and Statistics Canada. We measure total cost as the sum of an industry's wage bill and intermediate input expenditures. Labor cost shares are calculated as an industry's wage bill divided by its total cost. Data on bilateral trade between the U.S. and Canada are from the NBER website (see Feenstra, Romalis, and Schott, 2002) and relative price data are obtained from Inklaar and Timmer (2014) who compute industry-level output prices from purchasing power parities (PPP) collected for the 2005 International Comparisons Program.

Throughout, we work at the five-digit level of the North American Industry Classification System (NAICS) which is the most disaggregated level at which Canadian and U.S. industry definitions are identical. This yields a total of 160 manufacturing industries in the year 2002 for which we have data for all required variables.[11] We convert all value entries into U.S. dollars using the average U.S.-Canadian dollar exchange rate over the period 1997-2007.[12] In accordance with our choice of units and numéraire, we further normalize value entries by the average U.S. wage rate for the year 2002.[13]

Table 1 shows descriptive statistics for our empirical moments. On average, U.S. industries are over ten times larger in terms of total sales. They are also significantly less concentrated, as can be seen from the average HHIs (1281 in Canada vs. 601 in the U.S.). In the average sector, the Canadian prices are 7% higher than U.S. prices (11% in the median sector).

[11] Our trade data are originally at the ten-digit level of the harmonized system (HS) and we use the concordance by Pierce and Schott (2012) to map these data from HS into NAICS. The outuput price data are only available for 14 aggregate manufacturing industries, implying that our price data vary at a more aggregate level than our other data sources. As a robustness check, we will also calculate relative prices from more disaggregated trade unit values (see below for details).

[12] We use this 11-year average rather than the 2002 exchange rate because the latter is a clear outlier (1.57 CND/USD as opposed to the 11-year average of 1.37 CND/USD).

[13] We calculate U.S. and Canadian wage rates by dividing the economy-wide wage bill by the number of persons in employment. This yields an average wage for the U.S. of USD 36,510 and an average wage rate for Canada of USD 27,386 in 2002.

Table 1: Empirical Moments - Summary Statistics

Empirical Moment	Mean	Median	Standard Deviation	P10	P90
# Mergers US	2.18	1.09	4.00	0.10	4.22
# Mergers CAN	0.16	0.06	0.26	0.00	0.47
P^{CAN}/P^{US}	1.07	1.11	0.15	0.86	1.21
Shipments US	22205621	12473479	31082770	3408354	43858147
Shipments CAN	1593020	877455	2541084	177964	3482581
Exports US	527450	201771	1065915	25483	1203514
Exports CAN	758595	190372	2631997	31796	1665297
HHI US	601	417	561	106	1332
HHI CAN	1281	859	1184	194	2899
Total Cost US	16132940	9140820	23804465	2350389	33070284
Total Cost CAN	1784190	854798	3628505	175275	3703720
Observations	160	160	160	160	160

All data are at the 5-digit NAICS level for the year 2002. All value entries (shipments, exports, costs) are in 000s of current USD.

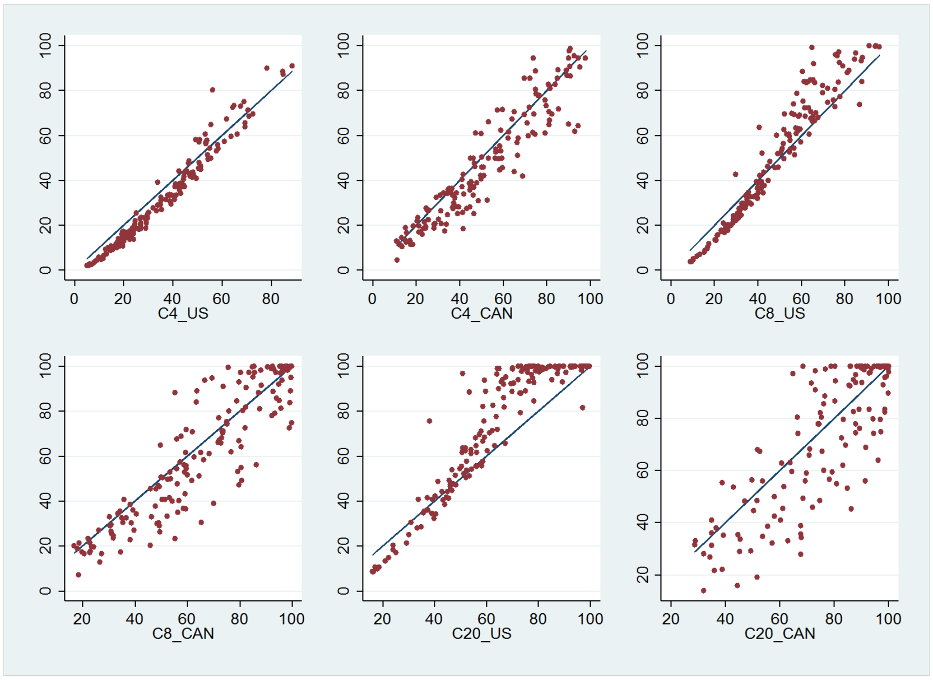
Calibration algorithm. We approximate our theoretical moments using Monte Carlo integration. For a given vector of parameter values Γ, we draw R realizations of the productivity vectors, where $R = 1000$. For each realization, we compute the model's equilibrium and calculate our nine theoretical moments. We take the simple averages of each theoretical moment across the R realizations and compare it to the corresponding empirical moments.[14] We iterate over Γ using standard derivative-based methods until we achieve a perfect fit.[15]

Identification. Each of our empirical moments has a natural parameter counterpart, allowing a straightforward illustration of how the parameters in Γ are identified. Parameter a^{CAN} governs the price elasticity of demand in Canada, which pins down the ratio of Canadian to U.S. prices, P^{CAN}/P^{US}. The ratio of country i's imports (Export^{ji}) to country i's domestic sales (Sales^{i}) is monotonically decreasing in τ^{ji}, and Export^{ji} and Sales^{i} are both proportional to $1/b^i$. This pins down b^i and τ^{ji}. The HHIs we are targeting are based on the value of production of domestic firms destined for both the domestic and foreign export

[14] In each sector, we observe one realization of domestic sales, exports, etc. The assumption we are making is that those observations provide good approximations for mean domestic sales, mean exports, etc. We then adjust parameter values so that our theoretical means match those empirical means. Since we do not have a sample, we cannot compute standard errors for our calibrated parameters.

[15] In practice, we minimize the sum of the squared residuals, where following Davis, Haltiwanger, and Schuh (1996), the residual is defined as the difference between the theoretical and empirical moments, divided by the arithmetic average of the theoretical and empirical moments. This residual converges to the percentage deviation when the theoretical moment tends to the empirical moment. Using this residual definition improves the convergence properties of our algorithm relative to using standard percentage deviations because residuals behave symmetrically (equal punishment for negative and positive deviations) and always remain bounded.

Figure 1: Theoretical vs. Empirical Moments (moments not targeted)



Figures plot theoretical moments (vertical axis) against empirical moments (horizontal axis). Each dot represents a sector. The straight line is the 45-degree line.

markets. Thus, ζ^i has a strong and positive impact on country i's HHI, and a much weaker one on country j's HHI. Similarly, the scale parameter of the productivity distribution of firms located in country i, x^i, has a direct impact on total costs in country i but only an indirect and much weaker impact on costs in country j. Hence, ζ^i is determined by country i's HHI and x^i by its total costs.

Goodness-of-fit and parameter values. We match our empirical moments almost perfectly in all sectors (see Figure IX.1.1 in Online Appendix IX.1). As a cross-validation check, Figure 1 plots the model fit for six moments that were not directly targeted in the calibration: the 4-, 8- and 20-firm concentration ratios in both countries. Our calibrated model does a reasonably good job at predicting these moments as well.

Panel A of Table 2 reports summary statistics on the parameters taken from the data. The U.S. is about one third more productive than Canada in the outside sector, and the average manufacturing sector in the U.S. has about six times as many firms as in Canada.

Panel B of Table 2 reports summary statistics on all calibrated parameters except for trade costs. In the median sector, a^{CAN} is very close to a^{US}, meaning that demand elasticities in the U.S. and Canada are quite similar.[16] In the median sector, $1/b^{US}$ is about 13 times higher than $1/b^{CAN}$, which, if we interpret $1/b$ as a market size parameter, is roughly consistent with the ratio of median U.S. to median Canadian industry sales (see Table 1).[17,18]

Given the importance of trade costs (τ) for our analysis, we report the corresponding parameter estimates in a separate table (Table 3). In addition to descriptive statistics for $\tau^{US,CAN}$ and $\tau^{CAN,US}$, we also show the same statistics for two measures of the difference between these trade costs to illustrate potential asymmetries in our estimates.[19] As seen, trade costs from the U.S. to Canada and from Canada to the U.S. are of comparable magnitude in both the average and the median sector. In the median sector, our calibrated τ's give rise to a tariff equivalent of around 50%, which is close to the 47% reported by Anderson and van Wincoop (2004, pp. 716–717).[20]

While the τ's are larger than one in most sectors, there are a few sectors in which they are smaller than one, which seems to be at odds with the conventional interpretation of iceberg trade costs.[21] This could be due to the fact that, in some sectors, a significant fraction of the U.S. industry is located close to the Canadian border. In such sectors, it may therefore be more costly for a U.S. firm to supply the average American consumer than it is to supply the average Canadian consumer. An alternative explanation for trade costs below one is that, in

[16] In the average sector, a^{CAN} is almost three times as high as in the U.S. We interpret these findings as follows. Canadian prices are higher than U.S. prices in the average and median sectors (see Table 1). Part of the reason for this is that Canada has fewer firms than the U.S., which suffices to rationalize the U.S.-Canada price ratio in the median sector. However, in a significant number of sectors, this price ratio is so high that differences in numbers of firms alone do not suffice, and the model needs to make Canadian consumers much less price-elastic than U.S. ones.

[17] The gap between $1/b^{US}$ and $1/b^{CAN}$ is significantly smaller in the average sector, but one should keep in mind that it is more difficult to think of $1/b$ as a market size parameter when the a's are allowed to vary.

[18] We obtain that $x^{US} < x^{CAN}$ in the average and median sectors. At the same time, there is more dispersion in productivity in the U.S. than in Canada ($\zeta^{US} < \zeta^{CAN}$). This result is driven by the fact that the U.S. has many more firms, which, for a given level of productivity dispersion, should imply much lower U.S. HHIs. While U.S. HHIs are indeed lower than Canadian ones in our data, the model still requires more productivity dispersion in the U.S. in order not to underpredict U.S. HHIs.

[19] We use the simple difference $\tau^{CAN,US} - \tau^{US,CAN}$ as well as the normalized difference $2\left(\tau^{CAN,US} - \tau^{US,CAN}\right) / \left(\tau^{CAN,US} + \tau^{US,CAN}\right)$.

[20] Although the U.S. and Canada are part of a free-trade agreement, there are good reasons to expect trade costs to remain significant. For instance, Anderson and van Wincoop (2004) report that border-related barriers such as tariffs only account for 25% of overall trade costs on average, with the rest being accounted for by other factors such as transportation costs or the time value of goods in transit. Due to those other factors, there is no particular reason why $\tau^{US,CAN}$ should necessarily be the same as $\tau^{CAN,US}$.

[21] The three sectors with the smallest $\tau^{CAN,US}$ are Petroleum Refineries, Copper Rolling, Drawing, Extruding, and Alloying, and Nonferrous Metal (except Aluminum) Smelting and Refining. The sectors with the largest $\tau^{CAN,US}$ are Office Furniture (including Fixtures) Manufacturing, Snack Food Manufacturing, and Textile and Fabric Finishing Mills. For $\tau^{US,CAN}$, the sectors with the lowest and highest trade costs are, respectively: Audio and Video Equipment, Construction Machinery, and Other Converted Paper Products; Breakfast Cereal Manufacturing, Ice Cream and Frozen Dessert Manufacturing, and Snack Food Manufacturing.

a given sector, products sold in the U.S. market are not the same as those sold in Canada. This could explain why a U.S. firm may find it cheaper to serve the Canadian market than its own domestic market.

Table 2: Parameter Values - Summary Statistics (Calibration without Mergers)

A) Parameters from Data	Mean	Median	Standard Deviation	P10	P90
α^{US}	1	1	0	1	1
α^{CAN}	0.750	0.750	0	0.750	0.750
N^{US}	1605.825	705	3147.181	134	3783.5
N^{CAN}	269.788	131.5	423.494	27.5	637.5
η^{US}	0.288	0.277	0.099	0.165	0.417
η^{CAN}	0.26	0.259	0.096	0.118	0.378
B) Calibrated Parameters	**Mean**	**Median**	**Standard Deviation**	**P10**	**P90**
a^{US}	25	25	0	25	25
a^{CAN}	69.279	23.699	122.487	7.077	180.666
$1/b^{US}$	18490.707	6343.944	46070.990	1155.054	40278.848
$1/b^{CAN}$	4992.182	475.525	28828.759	32.401	6383.334
ζ^{US}	5.414	4.987	2.958	2.568	8.251
ζ^{CAN}	11.585	8.328	9.545	4.611	24.179
x^{US}	0.376	0.183	0.635	0.051	0.690
x^{CAN}	0.488	0.270	0.699	0.086	1.114
Observations	160	160	160	160	160

We compute all parameters reported in the Table separately for each 5-digit NAICS industry. The Table reports summary statistics calculated across all industries.

Table 3: Trade Cost Parameters - Summary Statistics (Calibration without Mergers)

Parameter	Mean	Median	Standard Deviation	P10	P90
$\tau^{CAN,US}$	1.758	1.453	1.149	1.164	2.456
$\tau^{US,CAN}$	1.854	1.506	1.341	0.810	3.103
$\tau^{CAN,US} - \tau^{US,CAN}$	-0.096	0.064	1.414	-1.346	1.002
$\frac{2\left(\tau^{CAN,US}-\tau^{US,CAN}\right)}{\left(\tau^{CAN,US}+\tau^{US,CAN}\right)}$	0.036	0.047	0.538	-0.658	0.697
Observations	160	160	160	160	160

We compute all parameters reported in the table separately for each 5-digit NAICS industry. The table reports summary statistics calculated across all industries.

4.3 Counterfactual Experiments

Using our calibrated model, we now compute our conflict statistics ρ^{US} and ρ^{CAN} to look at which types of conflicts are most frequent, both at current trade costs (i.e., at our calibrated values for $\tau^{US,CAN}$ and $\tau^{CAN,US}$) and at higher and lower levels of trade costs. Figures 2 and 3 show how ρ^{US} and ρ^{CAN} change as trade costs vary. We consider uniform percentage changes in both $\tau^{US,CAN}$ and $\tau^{CAN,US}$. We recompute the equilibrium with the new trade cost parameters. This leads to new equilibrium prices (P^{US}, P^{CAN}) which we use to compute ρ^{US} and ρ^{CAN} for each sector. Figures 2 and 3 plot percentiles of the distribution of ρ^{US} and ρ^{CAN} across sectors for different trade cost changes.

According to our calibration results, at the original level of trade costs (0% change), U.S. merger policy is too tough on Canada in the majority of sectors; in only around 20% of sectors we have $\rho^{US} < 1$. By contrast, Canada is always too tough on its own domestic mergers from the point of view of U.S. consumers ($\rho^{CAN} > 1$). Intuitively, to the extent that iceberg trade costs are larger than one, domestic firms have less market power abroad than at home. If price levels were the same in the two countries, this would always lead to $\rho > 1$. However, the U.S. market is more competitive than the Canadian market in most sectors. This tends to reinforce the trade cost effect in Canada, leading to $\rho^{CAN} > 1$ in all sectors, but counteract the trade cost effect in the U.S., resulting in $\rho^{US} < 1$ in some sectors.

As implied by Proposition 2, the quantiles of ρ^{US} and ρ^{CAN} are increasing in trade costs. For trade cost reductions of 25%-30%, ρ^{US} and ρ^{CAN} decrease below one in the median sector, so that too-lenient-for-thy-neighbor behavior becomes the most prevalent form of conflict.

These results suggest that even if countries do have veto rights over foreign mergers, they may only use them infrequently at present levels of trade costs. This is particularly true for large, competitive economies such as the U.S. Hence, high-profile cases such as GE/Honeywell and Gencor/Lonrho, where the merger was approved by the domestic authority but blocked by a foreign authority, are likely to be the exception rather than the rule, even if national authorities do claim jurisdiction over foreign mergers. However, our calibration results suggest that veto rights become much more important for trade cost reductions that do not appear large from a historical perspective.[22]

4.4 Robustness Checks

We now briefly discuss a number of robustness checks. For details, the reader is referred to Online Appendix III–V and IX.2–IX.7.

Unit-value-based relative price data. As a first robustness check, we compute relative prices using unit values constructed from our sector-level trade data. While unit values

[22]See Jacks, Meissner, and Novy (2008) for estimates of trade cost changes over the period 1870 to 2000.

Figure 2: Potential Conflicts Arising from U.S. Mergers

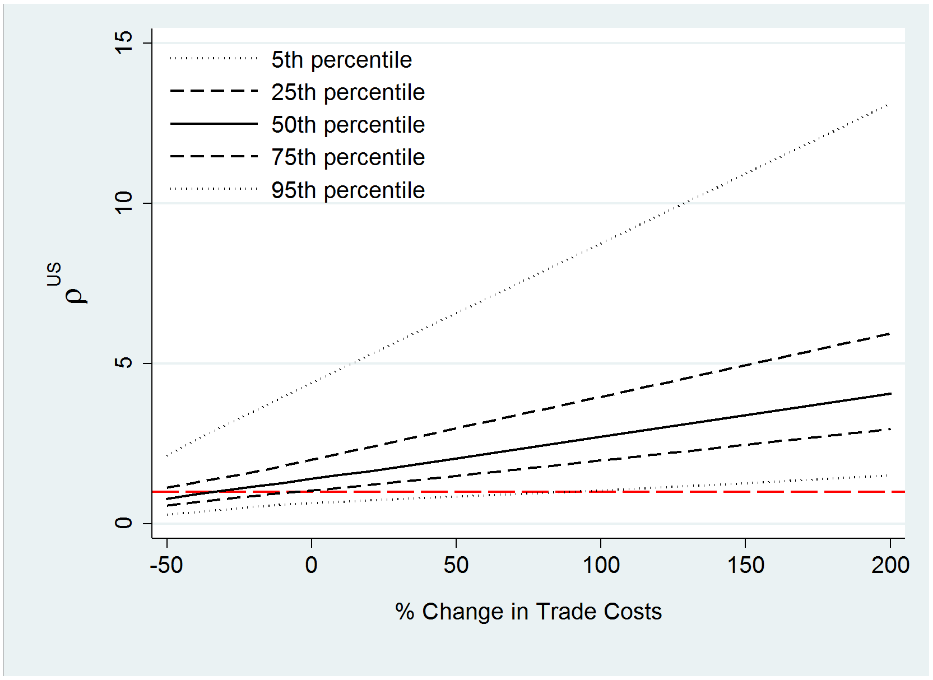


Figure shows percentiles of the distribution of ρ^{US} across sectors for different trade cost changes.

Figure 3: Potential Conflicts Arising from Canadian Mergers

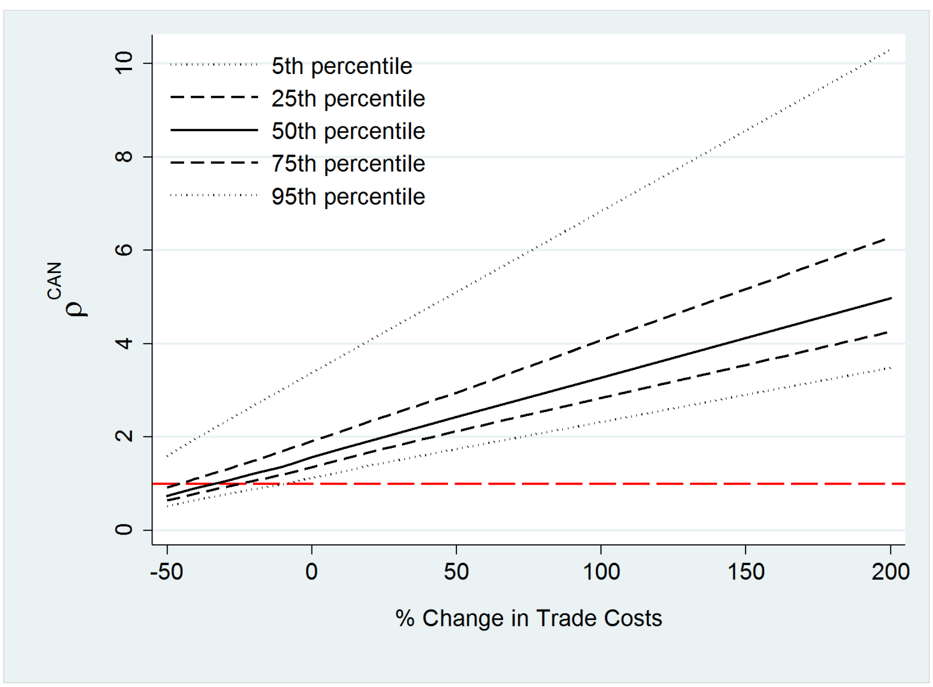


Figure shows percentiles of the distribution of ρ^{CAN} across sectors for different trade cost changes.

tend to be imprecisely measured and sometimes result in implausibly large price differences between the U.S. and Canada, they have the advantage of allowing the computation of relative prices at a finer level of aggregation than the PPP data.[23] Using unit-value-based relative price data leads to more dispersion in relative prices and slightly changes parameter values. However, the calibrated levels of trade costs are very similar to before and the U.S. continues to have lower prices than Canada. Our conflict statistics are also very similar to before, both at the current level and at lower/higher values of trade costs.

Competitive fringe. For our second robustness check, we explicitly model a competitive fringe. We assume that out of the total N domestic firms in each sector, N_o behave oligopolistically whereas the remaining $N - N_o$ firms belong to a price-taking fringe. In the absence of detailed information about the likely number of oligopolists in each sector, we set N_o to the number of the largest firms that jointly account for 80% of total sectoral sales in the data. The parameter values we obtain are broadly similar to before and the evolution of our conflict statistics is almost identical to the one reported in Figures 2 and 3.

Third-country imports. In our baseline calibration, we have ignored imports from the rest of the world. We explicitly model such imports in our third robustness check. Specifically, we assume that, in every sector, there are n^i identical third-country firms selling in country $i \in \{US, CAN\}$ with a constant unit cost of γ^i. We use information from the World Bank's Exporter Dynamics Database to construct a proxy for n^i and calibrate γ^i to match aggregate imports by country i from third countries, taken from the United Nations' Comtrade database. The parameter values and the evolution of our conflict statistics are broadly similar to the baseline calibration.

Additive trade costs. In our fourth robustness check, we replace iceberg-type trade costs by additive trade costs. The resulting parameter values (excluding trade costs) remain almost unchanged. Using the conflict statistics for additive trade costs defined at the end of Section 3, we find that at present levels of trade costs, both countries continue to be too tough in a

[23] We can compute unit value data separately for all 160 industries in our calibration whereas PPP data are only available for 14 aggregate sectors. Because unit value data are notoriously noisy, we average each industry's unit values over the period 1998-2006 and winsorize all data below the 10th percentile and above the 90th percentile of the distribution of unit values across industries before computing relative prices. Still, even the cleaned unit value data yield relative prices ranging from 0.5 to close to 3, implying persistent price differences of up to 200% in relatively narrowly defined industries (see Online Appendix Table IX.2.1). This is why we prefer to work with the more aggregated Inklaar and Timmer data for our baseline calibration, which yield more plausible price differences (see Table 1).

majority of sectors, with the U.S. being too lenient in a minority of sectors.

Constraining τ to be no smaller than 1. Our baseline calibration delivers values of the iceberg-type trade cost that are strictly less than 1 in some sectors. While such values of τ can be rationalized in several ways (see Section 4.2), trade costs below unity could be an issue as τ enters directly into our conflict statistic. We thus carry out a fifth robustness check in which the values of τ are constrained to be no less than 1. In sectors in which the constraint is binding, we can no longer expect to match all moments perfectly—we therefore minimize the sum of the squared deviations between theoretical and empirical moments. The fit of the calibration remains good and the parameter values we obtain are broadly similar to those in the baseline calibration. The values of our conflict statistics at current as well as higher and lower values of trade costs are also very similar to before.

CES-differentiated Bertrand competition. Our last robustness check involves replacing the homogeneous-goods Cournot model with a differentiated-goods Bertrand model and a CES demand system, building on Nocke and Schutz (2018a, b). Proposition 1 extends word for word if we replace P^{i*} and P^{j*} by the equilibrium CES price indices in countries i and j in the definition of conflict statistic ρ^{j*}. Calibrating the model, we show that, at current trade costs levels, ρ^{US} and ρ^{CAN} are larger than one in all sectors. As trade costs decrease, some of the ρs decrease below one, indicating that domestic merger policies are likely to become too lenient for foreign consumers in a number of sectors.

5 Model Calibration with Mergers

In this section, we try to put a monetary value on the costs and benefits of alternative ways of coordinating national merger policies. This requires much stronger assumptions: We have to model explicitly an endogenous merger formation process and take a stance on the strength of merger-specific synergies, on merger authorities' objective functions, and on whether the U.S. and Canada can veto each others' mergers.

We proceed in the following way. We again start out with N_s^i potentially active manufacturing firms in sector s and country i. Firms are then allowed to merge, leading to a new market structure in each country. We compute our theoretical moments at the end of the merger process and compare them to the same empirical moments described above. In addition, we also keep track of the number of mergers taking place during the merger process and match them to the actual number of mergers observed in the data in a given sector.

This section presents the results of our baseline calibration. We provide robustness checks in Online Appendix VI–VIII, recalibrating the model under various alternative assumptions: We vary the strength of merger-induced synergies, considering both stronger and weaker synergies relative to the baseline calibration; we allow for cross-border mergers in addition to domestic mergers; and we start from an initial situation in which countries have veto rights over foreign mergers.

5.1 Merger Formation Process

We use a tractable dynamic random matching approach to operationalize the merger formation process. In sector s, firms play a dynamic game with $T_s^1 + T_s^2 + 1$ periods, where T_s^1 and T_s^2 are parameters that capture frictions in the market for firm ownership. Nature randomly and uniformly draws T_s^1 periods in $\{1, \ldots, T_s^1 + T_s^2\}$ in which country 1 will receive merger opportunities, and the complementary T_s^2 periods in $\{1, \ldots, T_s^1 + T_s^2\}$ in which country 2 will receive merger opportunities.[24] From now on, we drop again sector subscripts.

Whenever two firms merge, the productivity of the merged entity becomes:

$$\overline{z}_M = \left(z_1^{\delta} + z_2^{\delta}\right)^{\frac{1}{\delta}},$$

where parameter δ governs the strength of synergies. Note that $\overline{z}_M > \max(z_1, z_2)$ for any $\delta \in (0, \infty)$, and that $\overline{z}_M$ is decreasing in δ. In the limit as $\delta \to \infty$, we have $\overline{z}_M = \max(z_1, z_2)$, which corresponds to the case of no synergies in the sense of Farrell and Shapiro (1990). Synergies are random and merger-specific: The δ associated with a merger is drawn from a log-normal distribution with mean $\ln(\beta_s^i) - \frac{1}{2}$ and variance 1, where β_s^i is a parameter.

Now, consider period $t \in \{1, \ldots, T^1 + T^2\}$ and suppose country i receives a merger opportunity. The within-period timing is as follows. 1) Nature randomly and uniformly draws two merger partners in country i: the acquirer and the target. Nature also draws a synergy parameter δ. 2) The acquirer can make a take-it-or-leave-it offer. 3) If an offer has been made, the target accepts or rejects. 4) If a merger proposal has been accepted, then the country-i antitrust authority decides whether to approve it. 5) Firms decide whether to stay in the industry. A firm that exits receives a positive but arbitrarily small scrap value. 6) Firms compete in quantities in both markets.[25]

[24]To improve the model's fit, we allow T^1 and T^2 to take non-integer values: The number of merger opportunities received by country i is equal to the integer part of T^i plus a Bernoulli random variable realized before the game starts, which takes value 1 with a probability equal to the fractional part of T^i.

[25]To accommodate sectors without mergers, we introduce a period 0, in which sub-stages 1–4 are dropped.

All players have a zero discount factor. This means that firms evaluate the profitability of mergers and make their exit decisions given the current market structure. This assumption is necessary to make our approach tractable, given the potentially large numbers of firms and periods. It implies that only those mergers will be proposed to the antitrust authority where the profit of the merged entity at the current post-merger market structure is strictly larger than the sum of the pre-merger profits of the merger partners. Similarly, due to the strictly positive scrap value, firms that do not produce in the current period will exit the market.

For simplicity, we assume here that both the U.S. and Canadian authorities have a consumer surplus standard.[26] In conjunction with the impatience assumption, this implies that antitrust authorities follow a simple rule: A merger is blocked if and only if it lowers domestic consumer surplus given the current market structure. Under these assumptions, our merger game has a unique subgame-perfect equilibrium. Given equilibrium strategies, we compute our theoretical moments at the end of stage $T^1 + T^2 + 1$.

5.2 Calibration Procedure and Results

To calibrate the model requires taking a stance on the strength of synergies. Unfortunately, the existing literature does not provide reliable estimates for a broad range of industries. Most papers in the merger simulation literature use arbitrary levels of synergies (Hausman, Leonard, and Zona, 1994; Werden and Froeb, 1994; Nevo, 2000).[27] A large empirical literature investigates the causes and consequences of mergers and acquisitions (e.g., Maksimovic, 2001; Schoar, 2002). Due to data limitations, these papers use revenue productivity instead of physical productivity to measure economic efficiency. This is problematic since mergers that increase market power tend to raise output prices and hence revenue productivity.[28] In light of this, we simply set $\beta^{US} = \beta^{CAN} = 50$ in all sectors, but provide robustness checks in Online Appendix VI. These parameter values along with the other calibrated parameters imply that, on average, an approved merger reduces marginal costs by about 7% in the median sector.

[26] Canada has long been thought of as having adopted a total surplus standard. However, in the last twenty years or so, the Canadian merger authority has been pushed towards putting a greater weight on consumer surplus: "As a result of [...] extensive litigation, it appears that the total surplus standard no longer serves as the basis for merger evaluation in Canada" (Gifford and Kudrle, 2005).

[27] A few papers use post-merger data to assess the accuracy of merger simulations and investigate the discrepancy between simulated and realized price effects (Peters, 2006; Weinberg and Hosken, 2013; Björnerstedt and Verboven, 2016). These papers do not attempt to disentangle changes in post-merger marginal costs from changes in industry conduct triggered by the merger. A recent exception is Miller and Weinberg (2017), who find that the 2008 MillerCoors joint venture reduced marginal costs by 13.6% on average.

[28] An exception is Braguinsky, Ohyama, Okazaki, and Syverson (2015), who, using data from the Japanese cotton spinning industry at the turn of the 20th century, find that acquired plants experienced productivity increases of around 13%.

We calibrate T^1 and T^2 so that the number of mergers taking place during the merger formation process matches the actual average annual number of mergers in each sector over the period 1993-2002.[29]

The fit of the new calibration remains very good.[30] There are only four out of 160 sectors in which we are unable to match merger activity in the data. We drop these sectors in the following although the results are similar if we include them.[31]

For each sector, the augmented calibration procedure also yields average price and marginal cost reductions induced by mergers during the merger formation process. Tables 4 and 5 show summary statistics on the distribution across sectors of these price and costs effects. For each sector, we calculate average price and marginal cost reductions as follows. Using our calibrated parameters, we recompute the model's equilibrium $R = 1000$ times. For each iteration, we observe a number of mergers, each of which entails synergies and induced price changes. Consistent with Farrell and Shapiro (1990), we compute merger synergies as the percentage decline in marginal costs of the merged entity as compared to the more efficient merger partner. We compute the average cost and price reductions over all mergers for a given iteration, and then take the mean of these averages across all R iterations.

As seen in Table 4, mergers tend to have larger effects on domestic prices than on foreign prices. The magnitude of those price effects varies significantly across sectors, from 0% to -2%. As each country can block domestic mergers, domestic price effects are all non-positive by construction. While cross-border price effects are also negative on average, U.S. mergers lead to price increases in a few Canadian sectors. Table 5 shows an average cost reduction of around 7% in the median sectors in both countries. This does not appear unreasonably large compared to the estimates we found in the literature (see Footnotes 27 and 28).

5.3 Counterfactual Policy Regimes

Trade costs and the scope for conflicts. The evolution of our conflict statistics with changes in trade cost is nearly identical to that shown earlier in Figures 2 and 3.[32] These results inform us only about the *potential* for conflicts. By allowing us to simulate the frac-

[29]The source of our merger data is Thomson SDC Platinum. In accordance with our model, we focus on domestic horizontal mergers, i.e., mergers in which both acquirer and target have the same primary industry classification and are both incorporated in either the U.S. or Canada.

[30]See Online Appendix Figures IX.8.1 and IX.8.2.

[31]Table IX.8.2 in the Online Appendix shows the new parameter values for the remaining 156 sectors. The estimates of our parameters already present in the first calibration are broadly similar to before. We find that T^{US} is significantly higher than T^{CAN} in the median and average sectors, reflecting the fact that the number of domestic U.S. mergers is over ten times as high as in Canada in the data (see Table 1).

[32]See Online Appendix Figures IX.8.3 and IX.8.4.

Table 4: Simulated Domestic and Cross-Border Price Effects of Mergers

Price Effect	Mean	Median	Standard Deviation	P10	P90
US merger, US price	-0.11%	-0.06%	0.12%	-0.26%	-0.01%
US merger, CAN price	-0.03%	-0.01%	0.09%	-0.09%	0.01%
CAN merger, CAN price	-0.14%	-0.07%	0.18%	-0.32%	-0.01%
CAN merger, US price	-0.08%	-0.01%	0.22%	-0.30%	0.00%

We compute the domestic and cross-border price effects of mergers separately for each 5-digit industry. The Table reports summary statistics calculated across all industries. Industries without merger opportunities are dropped.

Table 5: Synergy Effects

MC Reduction	Mean	Median	Standard Deviation	P10	P90
US mergers	-7.1%	-6.8%	2.8%	-10.0%	-3.2%
Canadian mergers	-11.1%	-7.2%	9.6%	-24.5%	-5.6%

We compute the synergy effects of mergers separately for each 5-digit industry. The Table reports summary statistics calculated across all industries. Industries without merger opportunities are dropped.

tion of profitable mergers for which the two antitrust authorities reach conflicting decisions, the new calibration provides a measure of *actual* conflicts. Figures 4 and 5 show that actual conflicts track potential conflicts closely. Again, the dominant conflict is that merger authorities block too many domestic mergers from the point of view of foreign consumers.[33] At present levels of trade costs, there are no mergers for which the Canadian authorities are too lenient and only a minority of cases where the U.S. authorities approve mergers that harm Canadian consumers. At trade cost declines of about 30%, the anti-competitive effects of foreign mergers become again the prevalent source of conflict.

Introducing veto rights. One way of eliminating too-lenient-for-thy-neighbor policies is to grant veto rights over foreign mergers. In general, such a policy has ambiguous effects: On the one hand, country i benefits from its antitrust authority being able to block CS-decreasing mergers taking place among country-j firms; on the other, country i suffers from country j being able to block CS-increasing mergers among country-i firms.

To quantify the costs and benefits of such a policy, we modify stage 4 in the merger game by assuming that a proposed merger must receive approval from *both* authorities.[34]

[33] The fact that a merger is blocked by a merger authority in our model does not necessarily imply that we would observe the same merger being blocked in the real world. If the merging parties are confident that their merger will be blocked, they have no reason to propose it in the first place.

[34] To eliminate undesirable equilibria in which country i blocks a CS-increasing merger because it expects country j to block it and vice versa, we assume that the domestic antitrust authority makes its approval decision before the foreign one.

Figure 4: Actual Conflicts, % of all profitable merger opportunities (U.S. mergers)

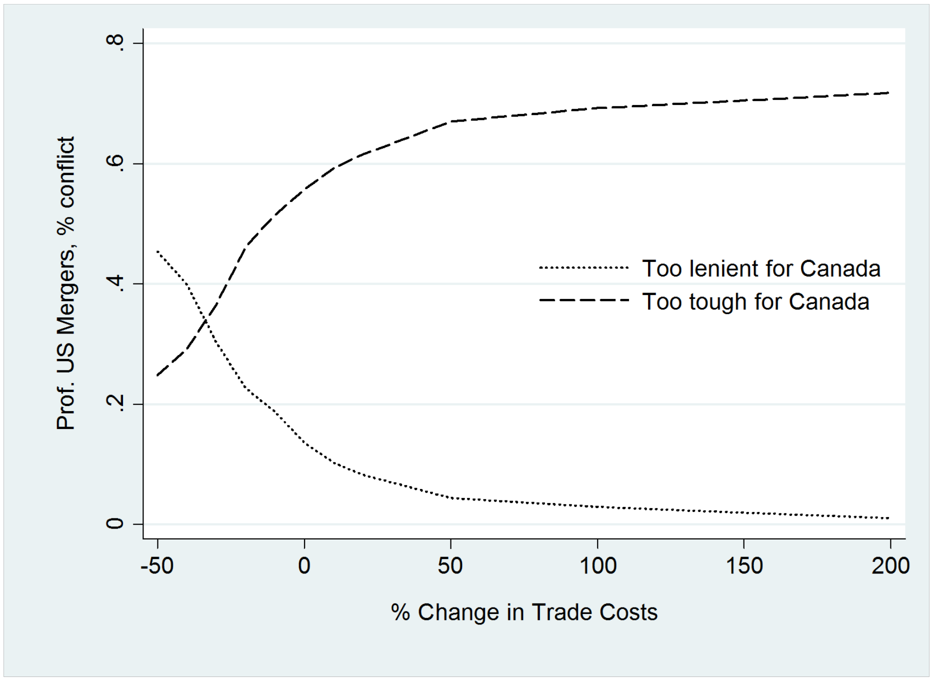


Figure shows means across sectors of the fraction of profitable mergers where a conflict arose. "Too lenient for Canada" means that the U.S. authorized a merger which lowered consumer surplus in Canada; "Too tough for Canada" means that the U.S. blocked a merger which would have increased Canadian consumer surplus. If there are no merger opportunities in a sector, the sector is dropped.

Figure 5: Actual Conflicts, % of all profitable merger opportunities (Canadian mergers)

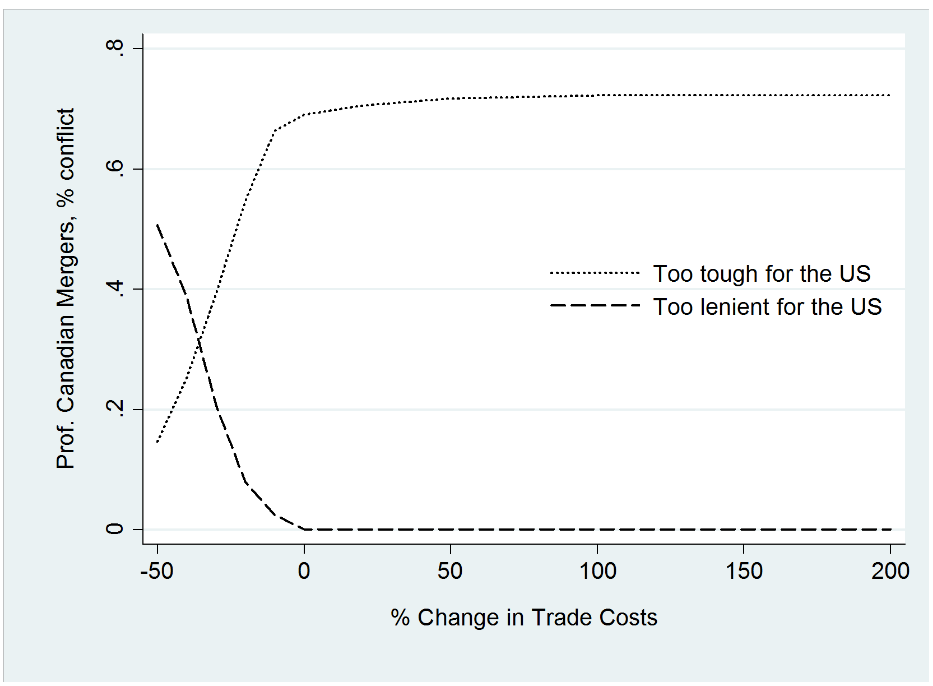


Figure shows means across sectors of the fraction of profitable mergers where a conflict arose. "Too lenient for the U.S." means that Canada authorized a merger which lowered consumer surplus in the U.S.; "Too tough for the U.S." means that Canada blocked a merger which would have increased U.S. consumer surplus. If there are no merger opportunities in a sector, the sector is dropped.

Table 6 shows that, at the present level of trade costs, the introduction of bilateral veto rights in our simulations reduces consumer surplus in the U.S. by USD 1.6 million in the average sector, and slightly increases Canadian consumer surplus, resulting in a reduction in total North American consumer surplus of USD 230 million across all 156 manufacturing sectors. In the median sector, this policy change has no effect on consumer surplus in either country. These findings are in line with our previous results that merger policy in Canada is of the too-tough-for-thy-neighbor type in all sectors, and that U.S. merger policy is of the too-lenient-for-thy-neighbor type in only a minority of sectors.

Table 6: Introducing Bilateral Veto Rights

Change in Outcome (000s USD)	Mean	Median	Standard Deviation	P10	P90
Total Consumer Surplus US+Canada	-1486.5	0	8505.5	-1056.2	0
Consumer Surplus US	-1618.7	0	9221	-1302.7	0
Consumer Surplus Canada	132.3	0	746.2	0	110.5

We compute the consumer surplus effects of introducing veto rights separately for each 5-digit industry. The Table reports summary statistics calculated across all industries.

Figure 6 shows that, as trade costs fall from current levels, Canadian consumers gain increasingly while the effect on U.S. consumers is non-monotonic. Recall that as trade costs fall, conflicts increasingly turn into the too-lenient-for-thy-neighbor type, implying that countries tend to gain more from being able to block foreign mergers. This is what is happening for Canada, which remains the less competitive market and thus has more to gain from the introduction of bilateral veto rights than the U.S. The flip side of this is that Canada blocks many U.S. mergers that would have benefited U.S. consumers. The interaction of these countervailing effects results in the non-monotonic impact in the U.S. For trade cost reductions of 50%, the gain in Canadian consumer surplus from introducing bilateral veto rights increases to over USD 3 billion, while the loss in U.S. consumer surplus is less than USD 160 million.

Introducing a North-American merger authority. National merger policies could also be coordinated through a supra-national authority that blocks a merger if and only if it decreases the sum of U.S. and Canadian consumer surplus.[35] In contrast to bilateral veto rights, such an authority mitigates not only the problem of too-lenient-for-thy-neighbor policies, but also that of too-tough-for-thy-neighbor policies.

[35]The European Commission is the only real-world example of a supra-national antitrust authority. The Commission has jurisdiction over mergers that have an "EU dimension." Our reading of the merger regulation is that the Commission would not approve a merger that raises prices in at least one of the member states—thus, the behavior of the Commission seems to be best approximated by our veto-rights policy regime.

Figure 6: Consumer surplus change, No-Veto to Veto Case

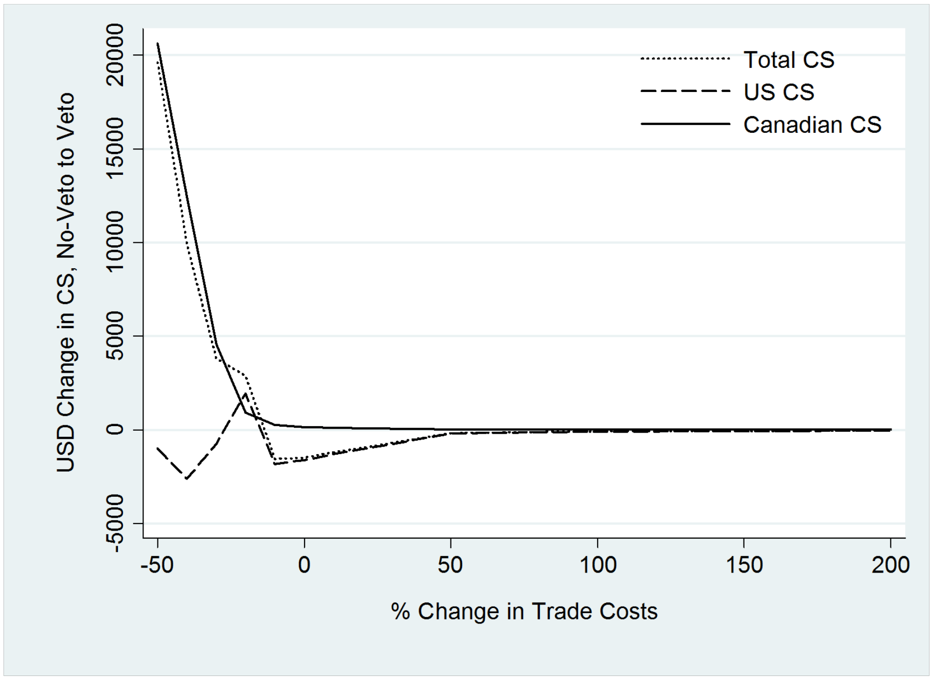


Figure shows the mean USD change in consumer surplus (in 000s of USD) induced by a move from no-veto rights to veto rights for different levels of trade cost changes.

As Table 7 shows, introducing such a supra-national authority results in a large gain in aggregate North-American consumer surplus of around USD one billion, but reduces Canadian consumer surplus by USD 86 million. Intuitively, due to the substantial market size advantage of the U.S., the new authority bases its decisions mainly on U.S. consumer surplus effects. As Canadian merger policy was initially too tough on domestic mergers from the viewpoint of the U.S., many such mergers are now approved by the supra-national authority.

Table 7: North-American Competition Authority

Change in Outcome (000s USD)	Mean	Median	Standard Deviation	P10	P90
Total Consumer Surplus US+Canada	7043	11.6	39422.8	0	2391.5
Consumer Surplus US	7593.2	0	44433.4	-31.3	1537.4
Consumer Surplus Canada	-550.3	2.4	5626.6	-51.4	153.6

We compute the consumer surplus effects of creating a North-American competition authority separately for each 5-digit industry. The Table reports summary statistics calculated across all industries.

Figure 7 looks at the consumer surplus changes induced by a supra-national authority at different levels of trade costs. Due to its size advantage, it is not surprising that the U.S. benefits from such a policy change regardless of the trade cost levels. Perhaps more

Figure 7: Consumer surplus change, No-Veto to North-American Competition Authority

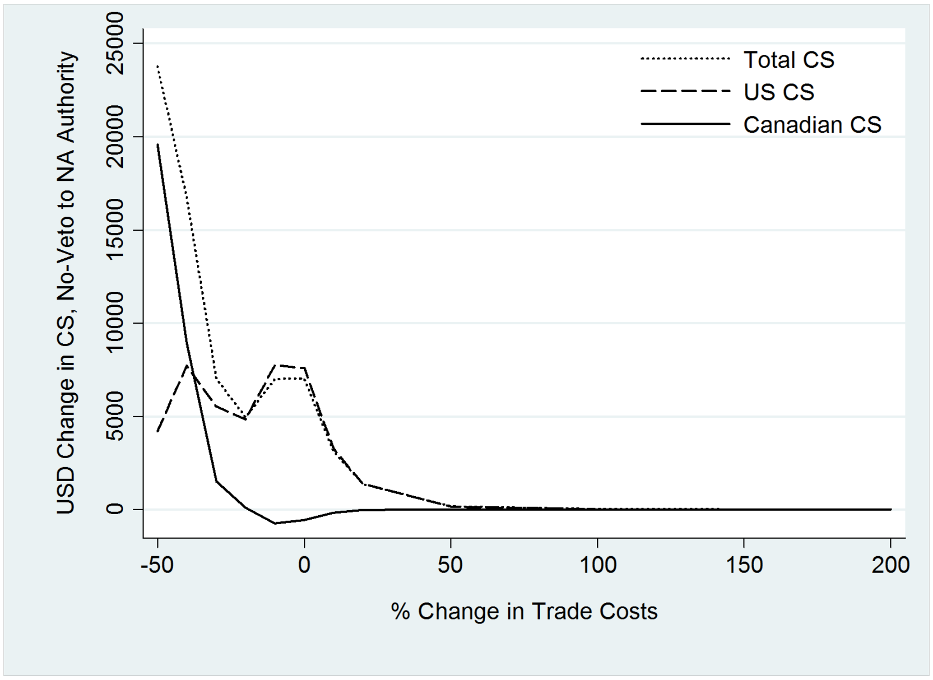


Figure shows the mean USD change in consumer surplus (in 000s of USD) induced by a move from the no-veto-rights case to a North-American merger authority for different trade cost changes.

surprisingly, Canada benefits as well—but only for sufficiently large trade cost reductions. The reason is that the supra-national authority blocks U.S. mergers that have only a small positive effect on U.S. consumers but a strong negative effect on Canadian consumers.

These results illustrate the interconnection of trade and merger policy. First, the level of trade costs determines the predominant type of conflict arising from domestic mergers and thus the distribution of gains from the introduction of a supranational merger authority. Second, in our calibration, the overall gains for the larger country remain positive throughout but change signs for the smaller country. This raises the possibility that the political feasibility of merger policy coordination may depend crucially on the level of trade costs between countries and thus on trade policy. Only if trade costs are sufficiently low is it in the smaller country's interest to agree to a merger approval standard maximizing joint consumer surplus.

6 Conclusion

Because of cross-border demand and supply linkages, merger approval decisions of national antitrust authorities can have important externalities on other jurisdictions. To analyze the resulting conflicts of interest between merger authorities, we analyze a two-country model of international trade with oligopolistic competition. Within this model, we identify the conditions under which merger control based on a domestic consumer surplus standard is too tough or too lenient from the viewpoint of foreign consumers. We show that the type of conflict depends only on the value of an industry-level sufficient statistic which summarizes the relative competitiveness of the home and foreign markets, adjusting for trade costs. A key result is that, unless trade costs and market asymmetries happen to exactly offset each other, the interests of the national authorities are never fully aligned, so conflicts can be expected to be frequent.

To judge what type of conflict is most prevalent in practice, we calibrate our model to match industry-level data for 160 U.S. and Canadian manufacturing sectors in the year 2002. Our results suggest that the majority of these conflicts are 'hidden', in the sense that they do not show in high-profile cases in which domestic authorities block foreign mergers. This is because, at current levels of trade costs, the main issue for the international coordination of merger policy is *not* that domestic authorities clear too many mergers from the viewpoint of foreign consumers. Rather, foreign consumers would like to see *more* mergers taking place abroad in the vast majority of sectors. Veto rights are thus a relatively inefficient tool when coordinating national merger policies. They cannot address the problem that domestic consumers mostly would like to see more, rather than fewer foreign mergers.

Our calibration results suggest that this situation might change dramatically as trade costs decrease, however. For trade cost reductions that do not appear large from a historical perspective (around 25-30%), conflicts arising from the consumer-surplus-decreasing effects of mergers taking place abroad become the dominant type of conflict. This indicates that merger policy and trade policy (or trade costs more generally) interact in an important sense. In our simulations, further reductions in trade costs make it more important for domestic authorities to be able to veto mergers taking place abroad.

We have shown that the above-mentioned calibration results hold across a range of standard assumptions on market structure. More generally, we believe that the main driving forces behind our results are differences in market structure and the presence of substantial trade costs, irrespective of the particular specification used. The finding that trade costs are still high despite decades of trade liberalization and reductions in transportation costs is not specific to our calibration, but has been shown in a wide variety of contexts and using different methodologies (e.g., Anderson and van Wincoop, 2004).

To get a better understanding of the quantitative importance of conflicts between merger authorities, we have also provided a second set of calibration results. These require much stronger assumptions (e.g., a specification of a merger formation process) but allow us to assign monetary values to the costs and benefits of international coordination of merger control. These results are in line with the idea that veto rights are not important at current levels of trade costs. By contrast, establishing a supra-national merger authority results in sizeable consumer surplus gains in our simulations because such an authority can address the conflict caused by too-tough-for-thy-neighbor policies. Perhaps surprisingly, these gains are highly asymmetric across countries, with Canadian consumers being worse off, suggesting that such a supra-national authority may be difficult to establish politically. However, the picture changes as trade costs fall. In our simulations, veto rights become much more valuable quantitatively, in particular for Canada as the smaller and less competitive country. As a consequence, a supranational merger authority increasingly addresses conflicts arising from too-lenient-for-thy-neighbor policies. This benefits Canada, making agreement on such an authority more likely.

In addition to providing a theoretical and quantitative analysis of international aspects of merger policy, the paper also makes a methodological contribution. It showcases how industry-level data can be used to put discipline on parameter values in international trade models with heterogeneous firms and oligopolistic competition. Our calibration techniques may be helpful to quantify some of the more qualitative insights from existing work in the area of international trade, such as those from the literature on strategic trade policy.

We see our paper as a first step for the quantitative study of the interactions between merger policy and trade policy. An exciting avenue for future research would be to endogenize those policies and study to what extent trade and merger policies are (strategic) complements or substitutes. A natural way of doing so would be to extend our framework by introducing strategic governments that choose, either non-cooperatively or through bilateral or multilateral bargaining, not only import tariffs but also merger policies.[36] An agreement over a merger policy could, for instance, be modeled as pinning down the respective weights the antitrust authority assigns to domestic consumer and producer surplus. One difficulty with bargaining over merger policies rather than tariffs is that agreements are much harder to enforce: While it is relatively straightforward to assess whether an agreed-upon tariff has been applied or not, it appears difficult to determine whether an individual merger should be approved or not given the agreed-upon objective function.

[36]See Bagwell, Staiger, and Yurukoglu (2017) for a recent example of an international trade model that features bilateral bargaining over tariffs in a multi-country world.

A Proofs

A.1 Proof of Lemma 1

Proof. Because firms are able to segment markets perfectly, we can focus on a single sector s and country i. We drop the sector index from now on for notational convenience. Fix a firm $k \in \mathcal{N}^1 \cup \mathcal{N}^2$ and let $Q^i_{-k} \equiv \sum_{l \neq k} q^i_l$ be the aggregate output of firm k's rivals in country i. The second derivative of firm k's profit with respect to q^i_k is given by:

$$P^{i\prime}\left(q^i_k + Q^i_{-k}\right) + \left(P^{i\prime}\left(q^i_k + Q^i_{-k}\right) + q^i_k P^{i\prime\prime}\left(q^i_k + Q^i_{-k}\right)\right),$$

which is strictly negative by Assumption 1.[37] Therefore, first-order conditions are sufficient for optimality, and we can use an aggregative games approach to establish equilibrium existence and uniqueness.

Firm k's profit-maximizing output in country i, conditional on aggregate output Q^i, is given by the fitting-in function (Selten, 1970)

$$h(Q^i; c^i_k) = \max\left\{0, -\frac{P^i(Q^i) - c^i_k}{P^{i\prime}(Q^i)}\right\}.$$

Assumption 1 ensures that there is at least one firm k such that $h(Q^i; c^i_k) > 0$ for Q^i sufficiently small, and that, for every k, $h(Q^i; c^i_k) = 0$ for Q^i sufficiently large. Let

$$\Gamma(Q^i; (c^i_k)_{k \in \mathcal{N}^1 \cup \mathcal{N}^2}) \equiv \sum_{k \in \mathcal{N}^1 \cup \mathcal{N}^2} h(Q^i; c^i_k) - Q^i.$$

The properties of the fitting-in function imply that $\Gamma(Q^i; (c^i_k))$ is strictly positive for Q^i sufficiently small and strictly negative for Q^i sufficiently large. By continuity, there exists an equilibrium level of aggregate output, denoted Q^{i*}, such that $\Gamma(Q^{i*}; (c^i_k)) = 0$. Notice also that $P(Q^{i*}) > c^i_k$ for some k.

Next, we establish uniqueness of this equilibrium aggregate output level. Suppose $\tilde{Q}^i$ is

[37] If $P^{i\prime\prime}\left(q^i_k + Q^i_{-k}\right) \leq 0$, then this is obvious. If instead $P^{i\prime\prime}\left(q^i_k + Q^i_{-k}\right) > 0$, then the expression is no greater than

$$P^{i\prime}\left(q^i_k + Q^i_{-k}\right) + \left(P^{i\prime}\left(q^i_k + Q^i_{-k}\right) + \left(q^i_k + Q^i_{-k}\right) P^{i\prime\prime}\left(q^i_k + Q^i_{-k}\right)\right),$$

which is indeed strictly negative by Assumption 1.

such that $\Gamma(\tilde{Q}^i;(c^i_k))$=0, and let $k \in \mathcal{N}^1 \cup \mathcal{N}^2$. If $P^i(\tilde{Q}^i) > c^i_k$, then:[38]

$$\partial_1 h(\tilde{Q}^i;c^i_k) = \frac{\left(P^{i\prime}(\tilde{Q}^i)\right)^2 - \left(P^i(\tilde{Q}^i)-c^i_k\right)P^{i\prime\prime}(\tilde{Q}^i)}{-\left(P^{i\prime}(\tilde{Q}^i)\right)^2} = \frac{-1}{P^{i\prime}(\tilde{Q}^i)}\left(P^{i\prime}(\tilde{Q}^i) + h(\tilde{Q}^i;c^i_k)P^{i\prime\prime}(\tilde{Q}^i)\right),$$

which is again strictly negative by Assumption 1. If $P^i(\tilde{Q}^i) < c^i_k$, then $\partial_1 h(\tilde{Q}^i;c^i_k) = 0$. Finally, if $P^i(\tilde{Q}^i) = c^i_k$, then $h(.;c^i_k)$ has a strictly negative left derivative and a right derivative equal to zero. It follows that $\Gamma(.;(c^i_k))$ is strictly decreasing in the neighborhood of $\tilde{Q}^i$. Hence, $\Gamma(.;(c^i_k))$ intersects the horizontal axis once and only once.

Finally, we prove that Q^{i*} is weakly decreasing in c^i_k, and strictly so if $q^{i*}_k > 0$. Let $c^{i\prime}_k > c^i_k$ and $c^{i\prime}_l = c^i_l$ for all $l \neq k$. Suppose first that $q^{i*}_k = 0$. Then,

$$\Gamma(Q^{i*};(c^{i\prime}_k)) = \Gamma(Q^{i*};(c^i_k)) = 0,$$

so the equilibrium aggregate output is not affected by an increase in c^i_k. Conversely, suppose $q^{i*}_k > 0$. Clearly, $h(Q^{i*};c^i_k) > h(Q^{i*};c^{i\prime}_k)$, and

$$\Gamma(Q^{i*};(c^{i\prime}_k)) < \Gamma(Q^{i*};(c^i_k)) = 0.$$

It follows that the equilibrium aggregate output is strictly decreasing in c^i_k. □

A.2 Proof of Lemma 2

Proof. To fix ideas, assume that $c_k \le c_l$. Merger M is CS-neutral in country i if, conditional on the pre-merger aggregate output Q^{i*}, the merged firm wants to produce exactly as much output as the merger partners did pre-merger. Using the same notation as in the proof of Lemma 1, this means that the merger is CS-neutral in country i if

$$h(Q^{i*};\overline{c}^i_M) = h(Q^{i*};c^i_k) + h(Q^{i*};c^i_l).$$

Rewriting, this means that

$$\max\left(P^i(Q^{i*}) - \overline{c}^i_M, 0\right) = \max\left(P^i(Q^{i*}) - c^i_k, 0\right) + \max\left(P^i(Q^{i*}) - c^i_l, 0\right),$$

[38]Notation: We denote by $\partial_k f$ the first partial derivative of function f with respect to its k-th argument, and by $\partial^2_{kl} f$ the second partial derivative of function f with respect to its k-th and l-th arguments.

or, equivalently, $\mu^i = 0$. If $c_k^i < P^i(Q^{i*})$, then equation $\mu^i = 0$ has a unique solution in $\overline{c}_M$:

$$\overline{c}_M = \widehat{c}_M^i \equiv c_k + \min\left(c_l - \frac{P^i(Q^{i*})}{\tau^{ji}}, 0\right).$$

Note that $\mu^i > 0$ if $\overline{c}_M < \widehat{c}_M^i$, and $\mu^i < 0$ if $\overline{c}_M > \widehat{c}_M^i$. As a decrease in $\overline{c}_M$ raises aggregate output by Lemma 1, it follows that merger M is CS-increasing in country i if $\mu^i > 0$, and is CS-decreasing if the inequality is reversed.

If instead $c_k^i \geq P^i(Q^{i*})$, then the merger is CS-neutral and $\mu^i = 0$ provided $\overline{c}_M \geq P^i(Q^{i*})/\tau^{ji}$. By Lemma 1, aggregate output is strictly decreasing in $\overline{c}_M$ over $(0, P^i(Q^{i*})/\tau^{ji})$. It follows that, if $\overline{c}_M < P^i(Q^{i*})/\tau^{ji}$, then the merger is CS-increasing and $\mu^i > 0$.

Suppose firms k and l are both active in country i before the merger. To see that merger M is profitable in country i if it is CS-neutral in that country, note that the price remains unchanged after the merger, the merged firm produces the same output as the merger partners did jointly before the merger, but the output is produced at lower costs after the merger as $\widehat{c}_M^i < \min\{c_k^i, c_l^i\}$. To see that a CS-increasing merger is profitable, note that it involves lower post-merger cost than a CS-neutral merger and that the joint output of the firms not involved in the merger is lower as well (as the fitting-in function $h(Q; c)$ is decreasing in Q). $\square$

A.3 Proof of Proposition 1

Proof. Consider a merger M between firms k and l, both of which are located in country j, and let $\bar{c}_M$ be the merged entity's post-merger marginal cost. To fix ideas, assume that $c_k \leq c_l$. Clearly, if $\bar{c}_M \geq c_k$, then merger M is CS-nonincreasing in both countries, and so this merger cannot give rise to conflict. Suppose instead that $\bar{c}_M < c_k$ and define

$$\mu(p) = \max\left(p - \bar{c}_M, 0\right) - \max\left(p - c_k, 0\right) - \max\left(p - c_l, 0\right), \quad \forall p > 0.$$

The function $\mu(\cdot)$ is continuous, identically equal to zero on $(0, \bar{c}_M)$, strictly increasing on $(\bar{c}_M, c_k)$, constant and strictly positive on (c_k, c_l), and strictly decreasing on (c_l, ∞). Moreover, $\mu(p) \underset{p\to\infty}{\longrightarrow} -\infty$. Hence, there exists a unique $\tilde{p} > c_l$ such that $\mu(\tilde{p}) = 0$.

Suppose that country j's merger control is too tough on merger M from the point of view of country-i consumers ($i \neq j$). By Lemma 2, this can arise only if $\mu\left(P^{i*}/\tau^{ji}\right) > 0 > \mu\left(P^{j*}\right)$. The properties of the function $\mu(\cdot)$ immediately imply that $P^{i*}/\tau^{ji} < \tilde{p} < P^{j*}$, i.e., $\rho^{j*} > 1$. The same reasoning implies that, if country j is too lenient on merger M, then $\rho^{j*} < 1$.

Now, suppose that $\rho^{j*} > 1$. The above reasoning implies that there is no merger for which country j is too lenient. Moreover, by assumption, there exist two country-j firms, k and l, that are active at home and abroad. For that merger, the fact that ρ^{j*} strictly exceeds 1 immediately implies that $\widehat{c}_M^j < \widehat{c}_M^i$. Thus, for any $\bar{c}_M \in (\widehat{c}_M^j, \widehat{c}_M^i)$, the merger is CS-decreasing at home and CS-increasing abroad. Country j's CS-standard is therefore a too-tough-for-thy-neighbor policy. Using the same reasoning, we also find that country j's CS-standard is a too-lenient-for-thy-neighbor policy whenever $\rho^{j*} < 1$. □

A.4 Proof of Proposition 2

Proof. For $i, j \in \{1, 2\}$, let

$$\overline{\mathcal{N}}^{ij} \equiv \left\{k \in \mathcal{N}^i : \ P^{j*} > c_k^j\right\}$$

denote the set of firms located in country i that are active in country j. In the following, we focus on the generic case where taking derivatives does not affect this set.[39]

Let $i \neq j \in \{1, 2\}$. Applying the implicit function theorem to equation $\Gamma(Q^i; (c_k^i)) = 0$, we obtain:

$$\begin{aligned} \frac{dP^{i*}}{d\tau^{ji}} = P^{i\prime}(Q^{i*})\frac{dQ^{i*}}{d\tau^{ji}} &= \frac{P^{i\prime}(Q^{i*})}{\tau^{ji}} \frac{\sum_{k \in \overline{\mathcal{N}}^{ji}} c_k^i}{\left(|\overline{\mathcal{N}}^{ii}| + |\overline{\mathcal{N}}^{ji}| + 1\right) P^{i\prime}(Q^{i*}) + Q^{i*} P^{i\prime\prime}(Q^{i*})}, \\ &< \frac{\sum_{k \in \overline{\mathcal{N}}^{ji}} c_k^i}{\tau^{ji}\left(|\overline{\mathcal{N}}^{ii}| + |\overline{\mathcal{N}}^{ji}|\right)} \leq \frac{P^{i*}}{\tau^{ji}}, \end{aligned}$$

where the first inequality follows from Assumption 1, and the second as $\left(|\overline{\mathcal{N}}^{ii}| + |\overline{\mathcal{N}}^{ji}|\right) P^{i*} - \sum_{k \in \overline{\mathcal{N}}^{ji}} c_k^i \geq \sum_{k \in \overline{\mathcal{N}}^{ji}} (P^{i*} - c_k^i) \geq 0$. It follows that the ratio τ^{ji}/P^{i*} is increasing in τ^{ji}. As P^{j*} is independent of τ^{ji}, this implies that $\rho^{j*} \equiv \tau^{ji} P^{j*}/P^{i*}$ is increasing in τ^{ji}. Moreover, as P^{i*} is increasing in τ^{ji}, $\rho^{i*} \equiv \tau^{ij} P^{i*}/P^{j*}$ is increasing in τ^{ji} as well. □

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[39] To account for the non-generic case in which infinitesimal changes of parameters do change the set of active firms, the derivatives in the proof would have to be replaced by one-sided partial derivatives; the results would remain unchanged.

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