Critical import supply elasticities and the 'imports-as-market-discipline' hypothesis

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Critical import supply elasticities and the 'imports-as-market-discipline' hypothesis[*]

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Abstract

This paper formally examines the factors underlying how responsive imports must be to domestic prices (the 'import supply elasticity') in order to thwart an anticompetitive domestic price increase stemming from a merger—an issue that frequently arises in many antitrust reviews. Domestic firms face a fringe comprised of foreign firms who import their products into the domestic market. In the eyes of domestic consumers, these imports are viewed as imperfect substitutes in demand to the output produced by the domestic firms. The model is solved in terms of the 'critical' import supply elasticity that can then be used evaluate the ability of imports to constrain an anticompetitive price increase post-merger. Both general and linear demand specifications are considered. Numerical simulations are conducted to consider the magnitude of perturbations in the model's exogenous parameters. Potential empirical extensions of the model are also considered.

Keywords: Competitive effects; Critical loss; Market definition; Import supply elasticity

JEL classification: L40; F10

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1 Introduction

The influence that foreign imports may have on constraining the exercise of market power held by domestic firms – referred to as the 'imports-as-market-discipline' hypothesis – has interested industrial economists for some time.[1] In recent years, the high industrial growth rates of several countries in Eastern Europe and the Far East have markedly increased the number of firms exporting into numerous domestic US markets, thereby potentially increasing the competitive pressure exerted by foreign suppliers even further. Accordingly, the presence and potential entry (or expansion) of foreign competitors in the domestic market may play an important role in the investigation by the antitrust authorities of proposed mergers between competing domestic firms.

The question of whether foreign firms should be viewed as constraining price increases by domestic firms has been a central issue in recent, high-profile antitrust cases. For example, the US Department of Justice (DOJ), in its approval of the controversial merger between Whirlpool and Maytag in 2006, found that the transaction was unlikely to reduce competition substantially in part because "…newer brands such as LG and Samsung have quickly established themselves in recent years. LG, Samsung, and other foreign manufacturers could increase their imports into the U.S."[2] According to the DOJ, these foreign manufacturers of household appliances could export sufficient quantities of product into the US to offset any incentive of a combined Whirlpool-Maytag to decrease its output and raise domestic prices.[3] The DOJ

[1] Theoretical treatments include Jacquemin *et al.* (1980), Lyons (1980), Pugel (1980), Huveneers (1981), and Kwoka (1998). Studies that (also) empirically test the hypothesis include Jacquemin *et al.* (1980), Pugel (1980), de Melo & Urata (1986), De Ghellinck (1988), Clark *et al.* (1990), Levinsohn (1993), Feinberg & Shaanan (1994), Katics & Petersen (1994), Hansson (1992), Field & Pagoulatos (1998), Min (1999), Thompson (2002), and Ghosal (2002).

[2] US Department of Justice, Antitrust Division, STATEMENT ON THE CLOSING OF ITS INVESTIGATION OF WHIRLPOOL'S ACQUISITION OF MAYTAG (March 29, 2006), *available at* <http://www.usdoj.gov/atr/public/press_releases/2006/215326.htm>.

[3] *See id.* ("The investigation revealed that a number of manufacturers, such as LG and Samsung, currently manufacture overseas high-efficiency, front-load washers and dryers and sell them successfully in the U.S. … companies such as LG currently manufacture top-load washers in Asia, and Samsung already manufactures top-load

effectively concluded that LG, Samsung, and other foreign manufactures could defeat a 'small but significant and non-transitory increase in price' (referred to as a 'SSNIP') imposed post-merger by Whirlpool-Maytag.

The DOJ's conjecture that foreign imports would constrain pricing by Whirlpool-Maytag has been criticized by some analysts. Baker & Shapiro (2008) argue that the recent, low-scale entry of foreign suppliers, such as LG and Samsung, into a mature market in which brand name is important does little to quell concerns that the transaction would not have any adverse effects on consumers. Baker & Shapiro consider two (arguably interrelated) questions: (1) would LG, Samsung, or other foreign manufacturers have the capacity and brand reputation to attract the business of large retail distributors; and (2) would domestic consumers whose first and second choices are Whirlpool and Maytag products view foreign products as 'sufficiently' close substitutes?

If the answers to the above questions are both 'no,' then the foreign appliance manufacturers would not be able to constrain a post-merger price increase. In this case, even a relatively large post-merger price increase imposed by the domestic hypothetical monopolist (merged firms) would not lead to a substantive increase in the amount of import quantities brought into the domestic market, thereby mitigating the extent to which foreign suppliers may constrain the post-merger exercise of market power by the merged firm.

From an antitrust analysis perspective, the question of whether the 'imports-as-market-discipline" hypothesis holds hinges on whether the 'import supply elasticity' – which measures the responsiveness of *foreign* imports to changes in *domestic* prices – is sufficiently large to offset any post-merger exercise of market power by merging domestic firms. We investigate this

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washers in Mexico for sale in Latin America. Thus, any attempt by the merged entity to raise prices in the sale of conventional top-load washers likely would be checked by … the threat that top-load washers made in Mexico or overseas could be sold into the United States, and the loss of sales to suppliers of front-load washing machines.").

issue analytically by drawing in part from the critical loss literature.[4] Critical loss has been used as a method for defining relevant antitrust product and geographic markets in a number of merger cases, but to date has not been fully considered in the context of whether foreign firms may constitute important competitive checks in domestic markets.

The paper proceeds as follows. Section 2 presents the general theoretical model based upon Huveneers (1981) in which domestic firms compete non-cooperatively in homogenous products *à la* Cournot and face a fringe of foreign firms who import into the domestic market. Imports are viewed in the eyes of domestic consumers as imperfect substitutes (*i.e.*, to varying degrees) to the output produced by domestic firms. We analytically derive an expression for the equilibrium domestic industry-wide price-cost margin (Lerner Index) and show how this markup relates to the import supply elasticity. We then consider how the components of this elasticity affect its magnitude.[5]

In Section 3 we examine a hypothetical merger in the context of the above model and an expression for the critical import supply elasticity – *i.e.*, the *minimum* value of the elasticity that would prevent a hypothetical domestic monopolist from unilaterally imposing a SSNIP post-merger. We explore how the critical import supply elasticity affects the magnitude of a *relative price increase* resulting from a *change* in the domestic market structure toward increased concentration resulting from a merger. The expression for the critical import supply elasticity in turn provides a formal test for determining the impact of foreign competitors that can be readily applied by the antitrust enforcement agencies. We also discuss the key determinants of the critical import supply elasticity and consider the implications of perturbing these factors.

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[4] *See*, *inter alia*, Harris & Simons (1989), Danger & Frech (2001), Langefeld & Li (2001), Katz & Shapiro (2003), O'Brien & Wickelgren (2003), Bauman & Godek (2006), Strand (2006), Weisman (2006), Baker (2007), and Coate & Williams (2007).

[5] The model developed herein could also be applied in cases that do not explicitly involve issues of international trade and foreign competition. For instance, it might be used to examine cases where a dominant firm facing a competitive fringe has used practices to abuse its dominant position and maintain market power.

Section 4 then presents a linear version of the model in which the critical import supply elasticity is derived. We show that that the comparative statics results from the general model also hold in the parameterized model. Section 5 offers some numerical simulations of the model in order to further gauge the magnitude of the relationship between the critical import supply elasticity and key model parameters. Finally, Section 6 offers concluding remarks and discusses the application of the formal analysis considered here to future empirical work.

2 Price-cost margins and the import supply elasticity

We consider a model of competition in which domestic firms compete non-cooperatively in homogenous products and play Cournot strategies. The domestic firms also face a fringe comprised of foreign firms who import their products into the domestic market. These imports, from the perspective of domestic consumers, are imperfect substitutes in demand to the output produced by domestic firms.[6]

We assume that there are n domestic firms indexed by i. Let q_{ih} denote the output of home firm i. The inverse demand curve for home output is given by

$$P_h = f(q_h, M) \tag{1}$$

where

$$q_h = \sum\nolimits_i q_{ih} \tag{2}$$

and M is the quantity of output imported by the competitive fringe. This inverse demand curve is decreasing in both home output and imports so that,

$$\frac{\partial f}{\partial q_h} < 0 \quad \text{and} \quad \frac{\partial f}{\partial M} < 0\,. \tag{3}$$

The demand and supply curves for imports are given by

[6] The basic model presented herein is derived from Huveneers (1981) and is an extension of the dominant firm-competitive fringe model from Stigler (1940).

$$M = Q_f\left(P_h, P_f\right) \tag{4}$$

and

$$M = S_f\left(P_f\right), \tag{5}$$

respectively, where P_f is the price of imports. The substitutability, albeit imperfect, between home output and imports implies

$$\frac{\partial Q_h}{\partial P_h} < 0, \frac{\partial Q_h}{\partial P_f} > 0, \frac{\partial Q_f}{\partial P_h} > 0, \frac{\partial Q_f}{\partial P_f} < 0\,, \tag{6}$$

where $Q_h\left(P_h, P_f\right)$ is the inverse of $f(q_h, M)$.[7]

The profit-maximization problem of home firm i is given by

$$\max_{q_{ih}} \Pi_{ih} = f(q_h, M)q_{ih} - C_{ih}(q_{ih})\text{, for all } i, \tag{7}$$

where $C_{ih}(q_{ih}) = c_{ih}q_{ih} + F_{ih}$ is firm i's total cost function . Firm i produces its output with constant marginal cost c_{ih} and fixed cost F_{ih}. The first-order condition associated with this maximization problem is given by

$$\frac{\partial \Pi_{ih}}{\partial q_{ih}} = P_h + q_{ih}\left[\left(1 + \frac{\partial f}{\partial M}\left\{\frac{\partial Q_f}{\partial P_h} + \frac{\partial Q_f}{\partial P_f}\frac{\partial P_f}{\partial P_h}\right\}\right)\frac{\partial f}{\partial q_{ih}}\right] - c_{ih} = 0\text{, for all } i. \tag{8}$$

Equilibrium in the import market implies,

$$\frac{dP_f}{dP_h} = \frac{\dfrac{\partial Q_f}{\partial P_h}}{\dfrac{dS_f}{dP_f} - \dfrac{\partial Q_f}{\partial P_f}}. \tag{9}$$

[7] The model implicitly subsumes the myriad sources of potential product differentiation between home and imported output. For instance, one might consider $P_f = P_h + td$ where d denotes distance and t the transportation cost. Thus, firms located in countries farther away from the home market would charge higher prices relative to firms located in closer countries. Clearly, in this case distance becomes the primary driver of product differentiation. The present model is more general in the sense that any source of potential product differentiation between foreign and home output may be considered, including brand name effects, service quality, the extent of the sales force or number of manufacturing plants located in the home market, *etc*.

Rearranging equation (8) and making use of equation (9) yields the following firm-specific price-cost margin (*i.e.*, the Lerner index)

$$\frac{P_h - c_{ih}}{P_h} = \frac{s_{ih}}{\eta_h}\left[1 + \frac{\varepsilon_{hf}\varepsilon_{fh}}{1 - \frac{\eta_f}{\sigma_f}}\right], \text{ for all } i, \tag{10}$$

where

$s_{ih} = \dfrac{q_{ih}}{q_h}$: firm $i's$ share of home output (> 0);

$\eta_h = -\dfrac{\partial Q_h}{\partial P_h}\dfrac{P_h}{q_h}$: the (absolute) own-price elasticity of demand for home output (> 0);

$\varepsilon_{fh} = \dfrac{\partial Q_f}{\partial P_h}\dfrac{P_h}{M}$: the cross-price elasticity of import $demand$ w.r.t the price of home output (> 0);

$\varepsilon_{hf} = \dfrac{\partial f}{\partial M}\dfrac{M}{P_h}$: the elasticity of the price for home output w.r.t import $demand$ (< 0);

$\eta_f = \dfrac{\partial Q_f}{\partial P_f}\dfrac{P_f}{M}$: the own-price elasticity of import $demand$ (< 0);

$\sigma_f = \dfrac{dS_f}{dP_f}\dfrac{P_f}{M}$: the own-price elasticity of import *supply* (> 0).

Multiplying both sides of equation (10) by firm i's market share s_{ih} and then summing over the home firms yields the industry-wide Lerner index,

$$\frac{P_h - c_h}{P_h} = \frac{HHI_h}{\eta_h}\left(1 + \frac{\varepsilon_{hf}\varepsilon_{fh}\sigma_f}{\sigma_f - \eta_f}\right) \tag{11}$$

where $c_h = \sum_i c_{ih}s_{ih}$ is the share-weighted industry marginal cost and $HHI_h = \sum_i s_{ih}^2$ where $HHI_h \in (0,1]$ is the sum of squared market shares, both defined with respect to domestic firms and their output levels.

Turner (1980, p. 155) notes that "it is the elasticity of import supply *with respect to changes in domestic prices* that constrains the prices domestic producers may set" (emphasis added).[8] This elasticity, in the context of the present model, is given by Definition 1.

[8] Some studies have used the import share of total domestic sales as a proxy for the constraint that foreign firms impart on domestic producers. Turner (1980), however, shows that a high import share is a sufficient, but not necessary, condition for the 'imports-as-market-discipline' hypothesis to hold. As such, our analysis is focused on

Definition 1. *The cross-price elasticity of import supply with respect to the price for domestic output ('import supply elasticity') is,*

$$\xi_S \equiv \xi_S(\varepsilon_{fh}, \sigma_f, \eta_f) = \frac{dS_f}{dP_h}\frac{P_h}{M} = \frac{\varepsilon_{fh}\sigma_f}{\sigma_f - \eta_f} > 0\,. \tag{12}$$

Therefore, given estimates of ε_{fh}, σ_f, and η_f, one could estimate the import supply elasticity. Under the assumption that these other elasticities are exogenous, a few observations are worth noting.

Observation 1. *The import supply elasticity is increasing in ε_{fh}, all else equal.*

The size of ε_{fh} reflects the degree to which consumers would be willing to substitute towards imports in response to a price increase for home output. If ε_{fh} is relatively small in magnitude, then consumers do not perceive imports and home output to be close substitutes. This effect would, of course, endogenously impact the magnitude of ξ_S, which would be smaller for lower values of ε_{fh}. That is, foreign firms recognize that consumers will not increase their consumption of imports very much even if the relative price of home output rises. This lowers the extent to which they would be willing to provide imports to the home market even if the relative price of home output rises.

Observation 2. *The import supply elasticity is increasing in σ_f, all else equal.*

Foreign firms can choose to supply the foreign market or the home market. An increase in the relative price of home output makes the home market more attractive to foreign firms relative to the foreign market. Therefore, in response to a relative price increase for home output we would expect foreign firms to shift their production away from the foreign market to the home market. The size of this shift depends on how responsive foreign firms are to changes in

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the cross-price elasticity of import supply with respect to the price for domestic output because this elasticity is more likely to reflect the economic effect of interest in conducting an antitrust merger review.

the import price. The more sensitive foreign firms are to changes in the import price (i.e. the greater is σ_f), the greater will be the shift to the home market in response to an increase in the relative price of home output. As a result, the import supply elasticity is increasing in the own-price elasticity of import supply.

Observation 3. *The import supply elasticity is decreasing in the absolute value of η_f, all else equal.*

An increase in η_f suggests that consumers are more sensitive to changes in the price of imports. Therefore a small increase in the relative price of home output, which is equivalent to a decrease in the price of imports, will lead to large changes in demand for imports. As a consequence, foreign firms will find it more profitable to import in response to a relative price increase for home output.

3 The import supply elasticity and the competitive significance of foreign firms

We turn now to the relationship between the import supply elasticity and the ability for a merged firm to impose a SSNIP. Specifically, we seek to determine how large the import supply elasticity must be so that foreign firms limit the post-merger ability of home firms to impose a unilateral or coordinated anticompetitive price increase.

Let P_0 denote the value of P_h that implicitly solves the n first-order conditions from equation (8). Substituting equation (12) into equation (11) and solving for P_0 yields

$$P_0 = \frac{\eta_h c_h}{\eta_h - HHI_h(1 + \varepsilon_{hf}\xi_S)}. \tag{13}$$

The denominator in equation (13) must be strictly positive in order to ensure that P_0 is strictly positive. It is worth noting that P_0 is decreasing in the import supply elasticity—the more

responsive foreign firms are to changes in the price of home output, the lower is the price of home output. This effect demonstrates the 'imports-as-market-discipline' hypothesis.

Now consider a merger by a subset m of the home firms. If we assume that: (1) the various elasticities in equation (13) are constant, at least in the short run; (2) that the post-merger price for home output is strictly positive and; (3) that the post-merger industry marginal cost does not change, then the post-merger price, P', must exceed the pre-merger price, P_0.[9]

Lemma 1. *The relative post-merger price change is,*

$$\frac{P' - P_0}{P_0} = \frac{\left(1 + \varepsilon_{hf}\xi_S\right)\Delta_h}{\eta_h - HHI_h{}'\left(1 + \varepsilon_{hf}\xi_S\right)}, \tag{14}$$

where $HHI_h{}'$ measures the post-merger level of concentration in the market for home output and $\Delta_h = HHI_h{}' - HHI_h$ is the change in concentration in the market for home output due to the merger.

Proof: $P' = \dfrac{\eta_h c_h}{\eta_h - HHI_h{}'\left(1 + \varepsilon_{hf}\xi_S\right)}$ and $P_0 = \dfrac{\eta_h c_h}{\eta_h - HHI_h\left(1 + \varepsilon_{hf}\xi_S\right)}$ imply

$$\begin{aligned}
P' - P_0 &= \left(\frac{\eta_h c_h}{\eta_h - HHI_h{}'\left(1 + \varepsilon_{hf}\xi_S\right)}\right) - \left(\frac{\eta_h c_h}{\eta_h - HHI_h\left(1 + \varepsilon_{hf}\xi_S\right)}\right) \\
&= \frac{\eta_h c_h\left(\eta_h - HHI_h\left(1 + \varepsilon_{hf}\xi_S\right) - \eta_h + HHI_h{}'\left(1 + \varepsilon_{hf}\xi_S\right)\right)}{(\eta_h - HHI_h{}'\left(1 + \varepsilon_{hf}\xi_S\right))(\eta_h - HHI_h\left(1 + \varepsilon_{hf}\xi_S\right))} \\
&= \frac{\eta_h c_h\left(1 + \varepsilon_{hf}\xi_S\right)(HHI_h{}' - HHI_h)}{(\eta_h - HHI_h{}'\left(1 + \varepsilon_{hf}\xi_S\right))(\eta_h - HHI_h\left(1 + \varepsilon_{hf}\xi_S\right))} \\
&= \frac{\eta_h c_h\left(1 + \varepsilon_{hf}\xi_S\right)\Delta_h}{(\eta_h - HHI_h{}'\left(1 + \varepsilon_{hf}\xi_S\right))(\eta_h - HHI_h\left(1 + \varepsilon_{hf}\xi_S\right))}.
\end{aligned} \tag{15}$$

Then,

[9] The assumption that industry marginal cost does not change post-merger is equivalent to assuming that there are no cost efficiencies arising from the merger. The motivation for merger in this case would be strictly to enhance market power. Primes, here and elsewhere, are used to denote post-merger values.

$$
\begin{aligned}
&\frac{P' - P_0}{P_0} \\
&= \frac{\left(\dfrac{\eta_h c_h \left(1 + \varepsilon_{hf}\xi_S\right)\Delta_h}{(\eta_h - HHI_h{}'\left(1 + \varepsilon_{hf}\xi_S\right))(\eta_h - HHI_h\left(1 + \varepsilon_{hf}\xi_S\right))} \right)}{\left(\dfrac{\eta_h c_h}{\eta_h - HHI_h\left(1 + \varepsilon_{hf}\xi_S\right)} \right)} \\
&= \frac{\eta_h c_h \left(1 + \varepsilon_{hf}\xi_S\right)\Delta_h}{(\eta_h - HHI_h{}'\left(1 + \varepsilon_{hf}\xi_S\right))(\eta_h - HHI_h\left(1 + \varepsilon_{hf}\xi_S\right))} \cdot \frac{\eta_h - HHI_h\left(1 + \varepsilon_{hf}\xi_S\right)}{\eta_h c_h} \\
&= \frac{\left(1 + \varepsilon_{hf}\xi_S\right)\Delta_h}{n_h - HHI_h{}'\left(1 + \varepsilon_{hf}\xi_S\right)}.
\end{aligned}
\tag{16}
$$

Q.E.D.

Let $\mathbf{X} \equiv \{n_h, \varepsilon_{hf}, \Delta_h, HHI_h{}', c_h, SSNIP\}$ denote the exogenous set of home and import own- and cross-price elasticities and other model parameters. Similar to Bauman and Godek (2006) and Weisman (2007), we define the critical value of ξ_S as follows.

Definition 2. *The critical value of ξ_S is given by,*

$$
\xi_S^* = \min\left\{ \xi_S : \frac{P' - P_0}{P_0} \leq SSNIP \mid \mathbf{X} \right\}, \tag{17}
$$

where SSNIP $\in$ (0,1). That is, the 'critical import supply elasticity' is the value of ξ_S that is just high enough such that the post-merger price for home output would not increase price by SSNIP-percent or more.

Proposition 1. *The critical value of ξ_S is,*

$$
\xi_S^* = \frac{\left(\eta_h - HHI_h{}'\right)SSNIP - \Delta_h}{\left(\Delta_h + HHI_h{}'SSNIP\right)\varepsilon_{hf}}. \tag{18}
$$

Proof: By Definition 2 and Lemma 1, the critical import supply elasticity satisfies the condition,

$$
\left(\eta_h - HHI_h{}'\left(1 + \varepsilon_{hf}\xi_S^*\right)\right)SSNIP \geq \left(1 + \varepsilon_{hf}\xi_S^*\right)\Delta_h .
$$

Collecting the ξ_S^* terms in the above expression gives,

$$\left(\eta_h - HHI_h{}'\right)SSNIP - \Delta_h \geq \left(\Delta_h + HHI_h{}'SSNIP\right)\varepsilon_{hf}\xi_S^*$$

$$\Rightarrow \xi_S^* \geq \frac{\left(\eta_h - HHI_h{}'\right)SSNIP - \Delta_h}{\left(\Delta_h + HHI_h{}'SSNIP\right)\varepsilon_{hf}}.$$

Evaluating the above expression at equality yields the result.

Q.E.D.

In order for the *critical* import supply elasticity to be strictly positive (unlike the general import supply elasticity in equation (12) that is positive by definition), we require,

$$SSNIP < \frac{\Delta_h}{\eta_h - HHI_h{}'} \text{ when } \eta_h > HHI_h{}'. \tag{19}$$

By Definition 2, the import supply elasticity (ξ_S) must be at least as great as some critical value (ξ_S^*) in order for a SSNIP to be defeated. Therefore, any time the inequality in equation (19) is violated the critical import supply elasticity is negative and a SSNIP is always defeated. This suggests that when demand for home output is 'sufficiently' elastic with respect to own-price a relatively large SSNIP (*i.e.*, $SSNIP > \Delta_h / \left(\eta_h - HHI_h{}'\right)$) will always be defeated. Therefore, the critical import supply elasticity is binding when home demand is relatively elastic with respect to own-price and the SSNIP is relatively small (*i.e.*, the inequality in equation (19) is satisfied).[10]

Observation 4. *The critical import supply elasticity is decreasing in the own-price elasticity of demand for home output (η_h).*

Observation 4 simply demonstrates that the more responsive consumers are to a change in the price of home output, the lower is the value of the import supply elasticity that is needed in order for foreign competitors to constrain a domestic price increase.

[10] For completeness, the critical import supply elasticity is also binding whenever demand for home output is inelastic with respect to own-price (*i.e.*, $\eta_h < HHI_h{}'$).

Observation 5. *The critical import supply elasticity is increasing in the change in the HHI (Δ_h).*

Observation 6. *The critical import supply elasticity is increasing in the post-merger level of concentration (HHI_h').*

Taken together, Observations 5 and 6 indicate that the more concentrated the market for home output becomes post-merger, both in terms of the absolute level of concentration and in terms of the change in concentration, the larger the import supply elasticity must be in order for foreign firms to defeat a SSNIP post-merger.

Observation 7. *The critical import supply elasticity is decreasing in the SSNIP.*

All else equal, the larger the post-merger SSNIP, then the larger is the increase in the relative price of home output. The substitutability between home and foreign output results in higher consumption of imports the larger is the SSNIP. As a result, foreign firms do not need to be as responsive to changes in the price of home output in order for the SSNIP to be defeated.

Observation 8. *If the critical import supply elasticity binding, then it is also decreasing in the elasticity of the price for home output w.r.t. import demand (ε_{hf}).*

A critical import supply elasticity which is strictly positive implies that the partial derivative of ξ_S^* with respect to ε_{hf} is strictly negative. If the price for home output is more sensitive to changes in import demand, then the change in import demand due to the relative price increase for home output post-merger will constrain somewhat the merged firm's ability to impose a SSNIP. As a consequence, foreign firms do not need to be as responsive to changes in the price of home output in order to defeat a SSNIP.

4 The case of linear demand

We now assume that there are just two domestic firms indexed by i and that the inverse demand curve for home output is given by,

$$P_h = f(q_h, M) = \alpha - q_h - \gamma M\,, \tag{20}$$

where $0 < \gamma < 1$ is the degree of substitution between home output and imports and $q_h = q_{1h} + q_{2h}$. As γ approaches zero the home output and imports become unrelated and as γ approaches one home output and imports become perfect substitutes. In addition, we also assume that the demand and supply curves for imports are given by,

$$M = Q_f\left(P_h, P_f\right) = \frac{(1-\gamma)\alpha + \gamma P_h - P_f}{1-\gamma^2} \tag{21}$$

and

$$M = S_f\left(P_f\right) = P_f - a\,, \tag{22}$$

respectively.

Lemma 2. *The linear demand assumptions in equations (25) - (27) yield the following set of derivatives:*

$$\frac{\partial f}{\partial q_{ih}} = \frac{\partial f}{\partial q_h} = -1, \quad \frac{\partial f}{\partial M} = -\gamma, \quad \frac{\partial Q_f}{\partial P_h} = \frac{\gamma}{1-\gamma^2},$$
$$\frac{\partial Q_f}{\partial P_f} = -\frac{1}{1-\gamma^2}, \quad \frac{dS_f}{dP_f} = 1, \quad \frac{dP_f}{dP_h} = \frac{\gamma}{2-\gamma^2}.$$

Proof. All of the derivatives, with the exception of $\frac{dP_f}{dP_h}$, follow directly from differentiation of equations (20)-(22). Substituting the relevant derivatives into equation (9) yields the result for $\frac{dP_f}{dP_h}$.

Q.E.D.

Using equation (8) and Lemma 2 we have,

$$P_h + q_{ih}\left[\left(1+(-\gamma)\left\{-1+(-\gamma)\frac{\gamma}{2-\gamma^2}\right\}\right)(-1)\right] - c_{ih} = 0\,. \tag{23}$$

Rearranging equation (23) and dividing both sides by P_h yields the firm-specific Lerner index,

$$\frac{P_h - c_{ih}}{P_h} = \frac{2\left(1-\gamma^2\right)}{2-\gamma^2}\frac{q_{ih}}{P_h} \tag{24}$$

Solving equations (20)-(22) and equation (24) simultaneously for P_h, q_{ih}, P_f, and M yields,

$$P_h = \frac{\left(1-\gamma^2\right)((2-\gamma)\alpha+\gamma a)+\left(2-\gamma^2\right)^2 c_h}{\gamma^4-6\gamma^2+6}, \tag{25}$$

$$q_{ih} = \frac{\left(2-\gamma^2\right)((2-\gamma)\alpha+\gamma a-2c_h)}{2\left(\gamma^4-6\gamma^2+6\right)}, \tag{26}$$

$$P_f = \frac{(1-\gamma)\left(3+\gamma-\gamma^2\right)\alpha+\left(\gamma^4-4\gamma^2+3\right)a+\gamma\left(2-\gamma^2\right)c_h}{\gamma^4-6\gamma^2+6}, \tag{27}$$

$$M = \frac{(1-\gamma)\left(3+\gamma-\gamma^2\right)\alpha-\left(3-2\gamma^2\right)a+\gamma\left(2-\gamma^2\right)c_h}{\gamma^4-6\gamma^2+6}. \tag{28}$$

In order for q_{ih} and M to be non-negative, we require,

$$\frac{\left(3-2\gamma^2\right)a-(1-\gamma)\left(3+\gamma-\gamma^2\right)\alpha}{\gamma\left(2-\gamma^2\right)} \le c_h \le \frac{1}{2}((2-\gamma)\alpha+\gamma a)\,, \tag{29}$$

and $\alpha \ge a$.

Lemma 3. *Under the linear demand assumptions of equations (20)-(22), the absolute own-price elasticity of demand for home output (η_h) is,*

$$\eta_h = \frac{\left(1-\gamma^2\right)((2-\gamma)\alpha+\gamma a)+\left(2-\gamma^2\right)^2 c_h}{\left(2-\gamma^2\right)((2-\gamma)\alpha+\gamma a-2c_h)}, \tag{30}$$

and the elasticity of the price for home output w.r.t. import demand (ε_{hf}) is,

$$\varepsilon_{hf} = -\frac{\gamma\left((1-\gamma)\left(3+\gamma-\gamma^2\right)\alpha-\left(3-2\gamma^2\right)a+\gamma\left(2-\gamma^2\right)c_h\right)}{\left(1-\gamma^2\right)((2-\gamma)\alpha+\gamma a)+\left(2-\gamma^2\right)^2 c_h}. \tag{31}$$

Proof. From equation (10), the absolute own-price elasticity of demand for home output is,

$$\eta_h = -\frac{\partial Q_h}{\partial P_h}\frac{P_h}{q_h},$$

and the elasticity of the price for home output w.r.t. import demand is,

$$\varepsilon_{hf} = \frac{\partial f}{\partial M}\frac{M}{P_h}.$$

Taking note of the fact that,

$$\frac{\partial Q_h}{\partial P_h} = \frac{1}{\left(\dfrac{\partial f}{\partial q_h}\right)}, \tag{32}$$

implies,

$$\eta_h = -\frac{\left(\dfrac{P_h}{q_h}\right)}{\left(\dfrac{\partial f}{\partial q_h}\right)}. \tag{33}$$

Substituting the values of P_h and q_{ih} from equations (25) and (26) and the value of $\dfrac{\partial f}{\partial q_h}$ from Lemma 2 into equation (30) yields the result for η_h. Similarly, substituting the values of P_h and M from equations (25) and (28) and the value of $\dfrac{\partial f}{\partial M}$ from Lemma 2 into the expression for ε_{hf} yields the result for the elasticity of the price of home output w.r.t. import demand.

Q.E.D.

Proposition 2. *Under the linear demand assumptions of equations (20)-(22), if the two home firms merge to form a monopoly, then the critical import elasticity is,*

$$\xi_S^* = \frac{\begin{pmatrix}\left(1-\gamma^2\right)((2-\gamma)\alpha+\gamma a)\\ +\left(2-\gamma^2\right)^2 c_h\end{pmatrix}\begin{pmatrix}((2-\gamma)\alpha+\gamma a)\left(2+2SSNIP-\gamma^2\right)\\ -2\left(2-\gamma^2\right)\left(1+\left(4-\gamma^2\right)SSNIP\right)c_h\end{pmatrix}}{\gamma\left(2-\gamma^2\right)(1+2SSNIP)\begin{pmatrix}(2-\gamma)\alpha\\ +\gamma a-2c_h\end{pmatrix}\begin{pmatrix}(1-\gamma)\left(3+\gamma-\gamma^2\right)\alpha\\ -\left(3-2\gamma^2\right)a+\gamma\left(2-\gamma^2\right)c_h\end{pmatrix}}. \tag{34}$$

Proof. In the case where the two home firms merge to form a monopoly, $HHI_h' = 1$ and $\Delta_h = \frac{1}{2}$. Substituting these values, along with the values of η_h and ε_{hf} from Lemma 3, into equation (18) from Proposition 1 yields the result.

Q.E.D.

Substituting the relevant values of HHI_h' and Δ_h into equation (19) we require,

$$SSNIP < \frac{1}{2(\eta_h - 1)} \text{ when } \eta_h > 1, \tag{35}$$

in order for the critical elasticity in equation (39) to be strictly positive and, therefore, binding.

Observation 9. *Under the linear demand assumptions of equations* (20)-(22)*, the critical import elasticity is decreasing in the SSNIP.*

Proposition 9 is consistent with the findings of Observation 7 for the general case. The critical import elasticity is binding when the demand for home output is elastic with respect to own-price. This means that as the SSNIP increases the diversion from home output, due to either not purchasing at all or to purchasing imports, will increase. Therefore, foreign firms do not need to be as responsive to the SSNIP in order for it to be defeated because this is being accomplished, to a greater extent, through the decrease in the consumption of home output.

5 Critical import supply elasticity simulations

This section presents numerical simulations of changes in the critical import supply elasticity, ξ_S^*, as effectuated by perturbations in key model parameters relating to the substitutability of domestic and foreign output. All simulations are conducted for the general case.[11] Figure 1(a) graphs ξ_S^* (given by equation (18)) as a function of ε_{hf} (which reflects the degree to which domestic consumers view the domestic good and imports as substitutes in

[11] Simulations pertaining to the linear case are qualitatively similar and available upon request.

consumption) at following parameter values: $\{\eta_h = 1.0\,;\ HHI_h' = 0.18\,;\ \Delta_h = 0.5\,;$ $SSNIP = 0.05\}$.

The critical import supply elasticity is shown to be a decreasing and convex in ε_{hf}. This result is intuitive: as the domestic price becomes more sensitive to an increase in the quantity of foreign imports (*i.e.*, as ε_{hf} becomes large in absolute value), the *minimum* value of ξ_S^* required to defeat a five percent SSNIP (at the given parameter values) falls. As ε_{hf} approaches zero ξ_S^* approaches infinity; accordingly, it would take 'infinitely large' import supply elasticity to offset any given SSNIP when consumers do not view domestic and foreign products are substitutes. Conversely, when the effective degree of substitution approaches infinity, the critical import elasticity approaches zero (although at a decreasing rate).

Figure 1(b) graphs the import supply elasticity frontier assuming $\eta_h = 10$ (indicating that the demand for domestic output becomes more own-price elastic) but holding all other parameter values at the same levels as before. The frontier exhibits the same general shape as Figure 1(a), but has shifted downward for every value of ε_{hf}. This result is also economically intuitive. As domestic consumers become more price sensitive to the price of domestically produced output, a lower value of ξ_S^* is needed to defeat a given SSNIP at any *given* value of ε_{hf}.

6 Concluding remarks

Foreign imports may be an important competitive check on the exercise of market power by domestic firms. Whether this is the case depends on how willing domestic consumers are to substitute foreign products for domestic ones, which in turn endogenously determines the extent to which foreign firms will export products in response to a domestic price increase. In this

paper we analytically derive an expression for this 'critical import supply elasticity,' which can be used to analyze the ability of foreign firms to constrain domestic price increases. If the value of this critical elasticity is 'sufficiently low,' then foreign production locations should be counted in the relevant (global) geographic market (and *vice versa*).

Our analysis demonstrates how, in the general case, the critical import supply elasticity is related to the domestic market structure as well as changes to that market structure (such as from a merger, for example), the own-price elasticity of domestic output, the extent to which domestic consumers are willing to substitute between foreign- and domestic-produced goods, and the magnitude of a hypothetical price increase effectuated by a merger. The impact of changes in each of these factors on the magnitude of the import supply elasticity, which determine whether the 'imports-as-market-discipline' hypothesis will tend to hold, are also considered. We also derive closed-form expressions for the critical import supply elasticity (and other parameters) in a model that relies upon linear demand functions for foreign and domestic goods.

Ultimately, implementing a competitive effects analysis requires some degree of empirical evidence (or at least casual observation to draw inferences). Our model highlights those data and estimation strategies that are likely to be required in order to appropriately conduct such an exercise when considering domestic markets facing the presence of foreign competition. Empirically determining the critical import supply elasticity requires obtaining estimates of the own-price elasticity of domestic demand and the other structural and behavioral parameters that define the expression. In addition, the inherent endogeneity underlying any structural model of import supply/demand will require the adoption of appropriate econometric techniques to separately identify demand and supply effects.

However, to date relatively few empirical studies have attempted to estimate export *supply* elasticities while carefully addressing endogeneity issues. Goldstein & Kahn (1978)

estimate both export demand and supply elasticities. Carey (1997) modifies the Goldstein & Kahn empirical framework to estimate import supply and demand elasticities via instrumental variables methods. Neither analysis, however, is concerned with conducting a competitive effects analysis through estimation of critical import supply elasticity as considered here. Extending the empirical methodologies used in these studies to estimate critical import supply elasticities should be a fruitful and useful endeavor for future empirical work and antitrust analyses of mergers involving foreign competition.

References

Bauman, Michael G. and Paul E. Godek (2006), A new look at critical elasticity, *Antitrust Bulletin* 51: 325-337.

Baker, Jonathan B. (2007), Market definition: An analytical overview, *Antitrust Law Journal* 74: 129-174.

Baker, Jonathan B. and Carl Shapiro (2008), Reinvigorating horizontal merger enforcement, in R. Pitofsky (ed.), *How the Chicago school overshot the mark: The effect of conservative economic analysis on US antitrust*: Oxford University Press.

Danger, Kenneth L. and H.E. Frech III (2001), Critical thinking about 'critical loss' in antitrust, *Antitrust Bulletin* 46: 339-355.

De Ghellinck, Elisabeth; Paul A. Geroski; and Alexis Jacquemin (1988), Inter-industry variations in the effect of trade on industry performance, *Journal of Industrial Economics* XXXVII: 1-19.

de Melo, Jamie and Shujiro Urata (1986), The influence of increased foreign competition on industrial concentration and profitability, *International Journal of Industrial Organization* 4: 287-304.

Carey, Catherine (1997), US import supply behavior: Evidence from the 1980s, *Eastern Economic Journal* 23: 139-149.

Clark, Don P.; David L. Kaserman; and John D. Mayo (1990), Barriers to trade and the import vulnerability of US manufacturing industries, *Journal of Industrial Economics* XXXVIII: 433-447.

Feinberg, Robert M. (1994), The relative price discipline of domestic versus foreign entry, *Review of Industrial Organization*, 9: 211-220.

Field, Martha K. and Emilio Pagoulatos (1998), Foreign trade elasticities and import discipline, *Applied Economics* 30: 105-111.

Ghosal, Vivek (2002), Potential foreign competition in US manufacturing, *International Journal of Industrial Organization* 20: 1461-1489.

Goldstein, Morris and Mohsin S. Kahn (1978), The supply and demand for exports: a simultaneous approach, *Review of Economics and Statistics* 60: 275-286.

Hanson, Pär (1992), The discipline of imports: The case of Sweden, *Scandinavian Journal of Economics* 94: 589-597.

Harris, Barry and Joseph Simons (1989), Focusing market definition: How much substitution is necessary?, *Review of Law and Economics* 12: 207-226.

Huveneers, Christian (1981), Price formation and the scope for oligopolistic conduct in a small open economy, *Recherches Economiques de Louvain* 47: 209-242.

Jacquemin, Alexis; Elisabeth De Ghellinck; and Christian Huveneers (1980), Concentration and profitability in a small open economy, *Journal of Industrial Economics* XXIX: 131-144.

Katics, Michelle M. and Bruce C. Petersen (1994), The effect of rising import competition on market power: A panel data study of US manufacturing, *Journal of Industrial Economics* XLII: 277-286.

Katz, Michael and Carl Shapiro (2003), Critical loss: Let's tell the whole story, *Antitrust* (Spring): 49-56.

Kwoka, John E. Jr. (1998), Herfindahl concentration with an import fringe and with supply constraints, *Review of Industrial Organization* 13: 401-407.

Langenfeld, James and Wenqing Li (2001), Critical loss analysis in evaluating mergers, *Antitrust Bulletin* 46: 299-337.

Levinsohn, James (1993), Testing the imports-as-market-discipline hypothesis, *Journal of International Economics* 35: 1-22.

Lyons, B. (1981), Price-cost margins, market structure, and international trade, in D. Currie, D. Peel, and W. Peters (eds.), *Microeconomic analysis: Essays in microeconomics and economic development*: Croom Helm, London.

Min, Byung (1999), Competition effects of import discipline in Korea, *Journal of the Asia Pacific Economy* 4: 298-316.

O'Brien, Daniel and Abraham Wickelgren (2003), A critical analysis of critical loss analysis, *Antitrust Law Journal* 71: 161-184.

Pugel, Thomas A. (1980), Foreign trade and US market performance, *Journal of Industrial Economics* XXIX: 119-129.

Scheffman, David; Malcolm Coate; and Louis Silvia (2003), Twenty years of merger guidelines enforcement at the FTC: An economic perspective, *Antitrust Law Journal* 73: 277-318.

Stigler, George (1940), Notes on the theory of duopoly, *Journal of Political Economy* 48: 521-541.

Strand, Niklas (2006), A simple critical loss test for the geographic market, *Journal of Competition Law and Economics*, 2: 697-707.

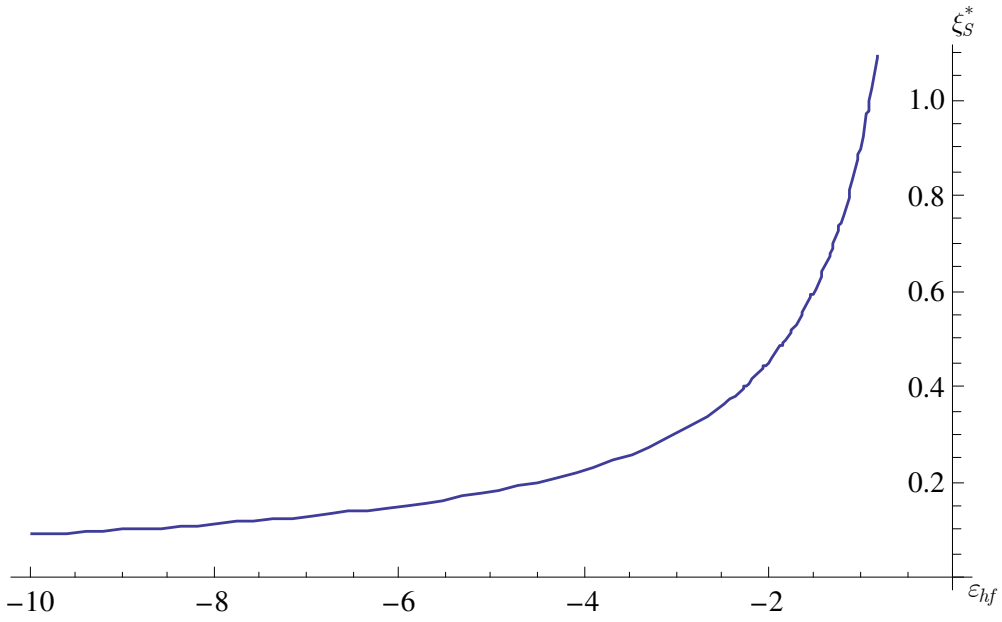
Thompson, Aileen J. (2002), Import competition and market power: Canadian evidence, *North American Journal of Economics and Finance* 13: 40-55.

Turner, Philip P. (1980), Import competition and the profitability of United Kingdom manufacturing industry, *Journal of Industrial Economics* XXIX: 155-166.

Weisman, Dennis L. (2006), When can regulation defer to competition for constraining market power? Complements and critical elasticities, *Journal of Competition Law and Economics* 2: 101-112.

FIGURE 1: GENERAL CRITICAL IMPORT SUPPLY ELASTICITY FRONTIER
$\{HHI_h' = 0.18\,;\ \Delta_h = 0.5\,;\ SSNIP = 0.05\}$

(a) $\eta_h = 1.0$



(b) $\eta_h = 10.0$