RESEARCH SEMINAR IN INTERNATIONAL ECONOMICS

Gerald R. Ford School of Public Policy
The University of Michigan
Ann Arbor, Michigan 48109-3091

Discussion Paper No. 634

Exporting Under Trade Policy Uncertainty: Theory and Evidence

Kyle Handley
University of Michigan

May, 2012

EXPORTING UNDER TRADE POLICY UNCERTAINTY: THEORY AND EVIDENCE

Kyle Handley*

Stanford University

First Draft: May 2009

This Draft: May 2012

Abstract

I provide novel evidence for the impact of trade policy uncertainty on exporters. In a dynamic, heterogeneous firms model, trade policy uncertainty will delay the entry of exporters into new markets and make them less responsive to applied tariff reductions. Policy instruments that reduce or eliminate uncertainty, such as binding trade policy commitments at the WTO, increase entry. The predictions are tested on disaggregated, product-level Australian imports with model-consistent measures of uncertainty. Reducing policy uncertainty generates more product entry than unilateral liberalization. The results illuminate and quantify an important new channel for trade creation.

JEL Codes: D8, D9, E6, F1, F5.

Keywords: policy uncertainty, trade, World Trade Organization, bindings

*Address: Stanford Institute for Economic Policy Research, Stanford University, 366 Galvez St, Stanford, CA 94305. Contact: handley@gmail.com

Acknowledgements: This paper is a chapter from my dissertation on trade policy uncertainty. I am grateful to Nuno Limão for many helpful discussions, suggestions and encouragement. I received helpful comments from Teresa Fort, John Haltiwanger, Russ Hillberry, Hiro Kasahara, Don MacLaren, Javier Miranda, Tim Moore, Ingmar Prucha, and John Shea as well as seminar participants at Maryland, the U.S. Census Bureau, Adelaide, Melbourne, Kansas City Federal Reserve, Oregon State, Stanford, Federal Reserve Board, UC-Davis, Dartmouth, Michigan, RMET, and ETSG. I thank the Australian Academy of Science for financial support and the Department of Economics at the University of Melbourne for hosting me while portions of this research were completed. This research was funded in part by NSF grant OISE-1015333. Jim Lang at Trade Data International (www.tradedata.net) provided the detailed Australian import data and useful insights.

1 Introduction

Policy commitment and credibility are often thought to be extremely important for inducing economic agents to make investments, particularly when they entail large irreversible costs. Trade policy is one area where commitment and credibility are potentially very important, but difficult to measure and quantify (Maggi and Rodriguez-Clare, 1998; Tang and Wei, 2009). This is unfortunate, since a founding purpose of the World Trade Organization (WTO) is to establish predictability[1]. Despite this objective, a substantial share of the trade between WTO members takes place under flexible trade policy regimes that are not secure. The impact on trade of this policy uncertainty is not well understood because most research focuses on trade policy in static, deterministic frameworks. I provide novel evidence that when trade policy is uncertain, multilateral policy commitments are an important channel of gains from trade agreements.

Even though the potential for large scale "trade wars" currently seems remote, trade policy uncertainty is pervasive in the world trade system. For example, in the wake of the financial crisis in 2008, leaders of the G-20 repeatedly pledged not to "...repeat the historic mistakes of protectionism of previous eras."[2] Such assurances were necessary because there exists wide scope for protectionism even *within* the WTO. Members make enforceable commitments not to raise applied tariffs above maximum binding constraints.[3] These "bindings" are presently well above applied tariffs in some countries. Over 30 percent of the tariff lines of WTO members could be increased unilaterally without providing compensation to affected trade partners (Bchir et al., 2005). Australia, for example, could raise tariffs from an average of 3.8 to 11 percent; Indonesia from 6.7 to 35.6 percent, and; the average developing country

[1]Under the principle "Predictability: through binding and transparency" the WTO explains that "Sometimes, promising not to raise a trade barrier can be as important as lowering one, because the promise gives businesses a clearer view of their future opportunities" http://www.wto.org/english/thewto_e/whatis_e/tif_e/fact2_e.htm (accessed October 27, 2010)

[2]http://www.londonsummit.gov.uk/en/summit-aims/summit-communique/ (accessed November 9, 2010).

[3]A country that violated its bindings would have to provide compensation to affected trade partners or face WTO sanctioned retaliatory tariffs.

from 8 to 28 percent (Messerlin, 2008). In short, the worst case scenario if governments were to backslide into protectionism, yet not violate any WTO rules is large.[4]

Securing multilateral commitments to eschew 1930s era protectionism was a founding principle of the General Agreement on Tariffs and Trade (GATT), the precursor of the WTO. The 1948 GATT charter explicitly states "binding against increase of low duties or of duty-free treatment shall *in principle* be recognized as a concession equivalent in value to the substantial reduction of high duties or the elimination of tariff preferences."[5] The use of tariff bindings and the existence of gaps between applied and binding rates are a feature of optimal trade agreements (Amador and Bagwell, 2011).[6] But in practice, the principle that constraints on future policy could be as valuable as applied tariff concessions has never been widely accepted or quantified; the trade off continues to be a considerable source of controversy in multilateral negotiations (Evenett, 2007; Mattoo and Subramanian, 2008).

My main contribution is to empirically examine the impact of tariff binding commitments, which lie at the heart of the GATT/WTO, on trade and export market entry. Little is known about effect of bindings on trade because most empirical research has focused on aggregate flows or applied protection. The cross-country study in Rose (2004), for example, questions whether there are any tangible benefits to WTO membership. In contrast, Subramanian and Wei (2007) find the WTO does promote trade when controlling for differential rates of liberalization and access to other preferences. Firm-level evidence in Buono and Lalanne (2012) finds weak extensive margin effects for the tariff changes induced by the Uruguay Round when the WTO was created. However, they do not control for the change in binding commitments induced by the round, instead focusing only on applied concessions.

Dixit's (1989) seminal paper on firm entry and exit under uncertainty shows that when sunk market entry costs are combined with uncertainty over future conditions there may be

[4]There are also other way to increase protection within the WTO that can and have been used in the past such as anti-dumping cases, invoking special safeguard tariffs, or raising other non-tariff barriers.

[5]Emphasis added. United Nations Conference on Trade and Employment, Final Act and Related Documents, Interim Commission for the International Trade Organization, April 1948, p. 31

[6]Beshkar et al. (2011) extend the theory and find empirical support for its predictions with WTO binding commitments.

an option value of waiting to invest. New exporters face both of these elements: evidence suggests there are large sunk cost of entry (cf. Roberts and Tybout, 1997) and there is substantial uncertainty over trade policy. Existing models of policy uncertainty have been largely theoretical. Francois and Martin (2004) provide simulation evidence that by truncating the distribution of tariffs, WTO bindings on agricultural products reduced tariff volatility and raised welfare. In an independent theory piece, Sala et al. (2010) model the impact of bindings in a real options framework but don't provide empirical evidence; they solve the model numerically and then assess the impact of changes in tariffs and bindings for different parameterizations. I provide a bridge from the theory to evidence by extending the tractable, heterogeneous firms trade model in Handley and Limão (2012) to encompass binding tariff commitments. Prospective entrants compare the value of beginning to export today versus waiting. On the margin, the present value of the difference between exporting and waiting reflects only the potential for "bad news" and this leads firms to delay entry. Bindings reduce uncertainty by constraining the range of observable tariffs and limiting losses in the worst case scenario.

I use the model to empirically quantify the policy uncertainty that arises through gaps between applied tariffs and bindings for developed country members of the WTO. I formulate the model in terms of a latent variable capturing the value of entry and estimate a linear probability model of observing trade in a disaggregated product as a measure of firm entry. This approach is complementary to Handley and Limão (2012), who focus on how preferential trade agreements can reduce trade policy uncertainty and induce entry rather than how variation in bindings at the WTO effects entry. Using firm-level data, they show that the reduction in uncertainty following Portugal's accession to the European Community explains a substantial share of net entry into EC markets. The method used here is novel for two reasons: first, I am able to use the observable levels of tariff bindings to *test* for the impact of uncertainty with *product-level* data when the standard deterministic model is nested as the null hypothesis; second, the uncertainty measures can be directly controlled by policy so

I can use the estimated model to quantify the relative impact of reducing applied protection versus the impact of reducing binding commitments.

The empirical method requires detailed product level trade data and corresponding data on applied and bound tariffs for a single importer. I focus on Australia's "most favored nation" trade partners in the years 2004 and 2006. High quality and detailed data on products and tariffs are available during this period and, more importantly, there is wide variation across products in binding commitments. As described in Section 4.2, other aspects of Australian trade policy raise issues of uncertainty that are hardly unique to this application. I find that lowering bindings, while holding applied tariffs fixed, brings the entry decision forward by reducing the incentive to delay investment. The estimates indicate that the cautionary effect of uncertainty makes firms over 40 percent less responsive to tariff reductions on average. The model predicts that if Australia unilaterally reduced tariffs to free trade levels, the number of traded products would increase by 4 percent. Alternatively, if Australia both reduced tariffs to zero and bound them through WTO commitments, the combined impact of removing the motives for caution and delay would increase the number of traded products by 11 percent. More than half of the share of new product growth is accounted for by reducing uncertainty. These estimates empirically quantify the value of binding tariff commitments for the first time.

2 Deterministic Model

The setup is similar to Chaney (2008) and Helpman et al. (2008), but extended to a deterministic multi-period framework. The world has J exporting countries indexed by j. I consider a single importer, but the model can be extended to a multi-country world. Goods shipped to the importing country are subject to tariffs, which may vary by product and country of origin. In the following section, I extend this analysis to a stochastic tariff process as in Handley and Limão (2012) and derive testable predictions for role of policy uncertainty and bindings on trade.

2.1 Preferences

Utility in the importing country is a Cobb-Douglas function over a homogeneous traditional good traded on world markets at zero cost and a continuum of differentiated varieties indexed by i:

$$U = q_0^{1-\mu} \left(\int_{i \in \Omega} q(i)^{\alpha} di \right)^{\mu/\alpha}, \quad \alpha = \frac{\sigma - 1}{\sigma} \tag{1}$$

where $\sigma > 1$ is the elasticity of substitution between varieties and $\mu \in (0, 1)$ is the expenditure share of differentiated goods. The total set of varieties available Ω is the union of all domestically produced varieties and those that are imported. Utility is maximized subject to the budget constraint on total income Y:

$$p_0 q_0 + \int_{i \in \Omega} p(i) q(i) di = Y. \tag{2}$$

This yields the usual demand function for any particular variety i of $q(i) = \mu Y \frac{p(i)^{-\sigma}}{P^{1-\sigma}}$. Varieties are differentiated by firm. The price $p(i)$ is the delivered consumer price in the importing country inclusive of tariff and transport costs. The price index is $P = \left[\int_{v \in \Omega} p(i)^{1-\sigma} di \right]^{1/(1-\sigma)}$.

2.2 Production and Tariff Barriers

The homogeneous good is freely traded and produced under CRS such that one unit of the good is produced for $1/w_j$ units of labor in country j. I let q_0 be the numeraire and normalize its price to unity, $p_0 = 1$. Labor market clearing implies that the wage for country j is w_j. The differentiated goods are subject to ad-valorem tariffs that may vary by exporter j. I let τ_j equal one plus the ad-valorem tariff for goods shipped from country j. Tariffs are paid at the border by consumers on the factory price.

Each firm in country j is identified by its unit labor requirement c_j, which is heterogeneous across firms. The market is monopolistically competitive. Firms chooses prices to maximize profits of $\pi_j = [p_j(c_j)/\tau_j - w_j c_j]q(i)$. This yields the standard markup rule with a delivered price of $p_j(c_j) = \tau_j w_j c_j/\alpha$. Combining the the markup rule, consumer demand and variable costs, the per period operating profits of an exporter in country j are

$$\pi_j(c_j) = A_j \tau_j^{-\sigma} c_j^{1-\sigma} \tag{3}$$

where $A_j = (1-\alpha)\mu Y \left[\frac{w_j}{P\alpha}\right]^{1-\sigma}$ summarizes exporter cost and importer demand conditions.

I assume there is a distribution of unit costs, $G(c)$, that summarizes the heterogeneity in productivity $(1/c)$ within each country and is bounded below at c^L. I index variation in aggregate productivity across exporting countries by $1/M_j$. Then the lowest unit cost firm in country j is $c_j^L = M_j c^L$.

2.3 Entry, Exit and Sunk Costs

There is a fixed cost of market entry K_e paid by a firm to begin exporting. Entry costs cover the expenses of setting up a distribution network, on-site visits or agency costs, marketing, tailoring products to local markets and complying with safety regulations. There are no fixed entry or per period maintenance costs in a firm's domestic market. Since operating profits are always positive, albeit potentially quite small, every firm sells in its home market. A subset of firms pay the entry cost and begin exporting if their unit costs are below a threshold cutoff level. Following Melitz (2003), exit is induced by an exogenous death shock δ. A firm that is hit by the death shock exits immediately without recouping its sunk costs.

In a deterministic environment, where $\pi_j(t) = \pi_j$ in the foreseeable future, the firm will enter an export market if the net present discounted value of entry is positive, such that

$$V^D = \frac{\pi_j}{1-\beta} - K_e \geq 0 \tag{4}$$

The superscript D denotes a "deterministic" tariff regime. The discount factor combines the true discount rate ρ and the death shock such that $\beta = (1-\delta)/(1+\rho)$. Free entry implies that in equilibrium $V^D = 0$ for the marginal entrant. Imposing this condition yields a multi-period zero cutoff profit threshold for unit labor costs c_j^D

$$c_j^D = \left[\frac{A_j \tau_j^{-\sigma}}{(1-\beta)K_e} \right]^{1/(\sigma-1)} \tag{5}$$

All firms with unit costs below c_j^D will pay the entry cost and begin exporting. It is straightforward to derive that the elasticity of c_j^D to a once-and-for-all change in τ is $\frac{\sigma}{\sigma-1}$.[7]

3 Stochastic Model

3.1 A framework for trade policy uncertainty

In practice, the level of future tariffs is uncertain. Many factors can affect the formation of trade policy over time. I take shocks to trade policy as given and do not explicitly model their source. Tariffs are a random variable with two sources of variation: uncertainty over the timing of policy changes, and uncertainty over the magnitude of those changes when they arrive. Even though the outcome of policy changes is unknown *ex-ante*, firms can form expectations over the likely tariff outcomes.

To model tariff uncertainty, I assume shocks to the path of tariffs arrive with probability γ per unit of time.[8] When a shock arrives, a policy maker sets a new tariff τ'. Firms know the value of γ and can assign probability measures to different tariff outcomes. The space of potential tariff outcomes and their likelihood are summarized by the distribution function $H(\tau')$ with support $[1, \tau_{max}]$. The support spans from free trade ($\tau = 1$) to autarky when

[7] This is higher than the usual elasticity of unity because tariffs are paid at the border, rather than as part of the firm's variable trade cost technology.

[8] In continuous time, a similar Poisson process for the arrival of tax policy changes can be found in Rodrik (1991) and Hassett and Metcalf (1999).

letting $\tau_{max} \to \infty$.

The model permits a straightforward treatment of the impact of bindings on the entry decision. A credible WTO binding is the maximum tariff permitted by WTO rules. The commitment to bind tariffs is a constraint on observable tariff outcomes such that the distribution of future tariffs, $H(\tau')$, is censored at the binding. By analogy to Tobit regression, censoring captures the idea that a policy maker might want to set a tariff above the binding but WTO legal constraints mean that only the binding tariff is actually observed.

I let B denote the level of the binding, which must be below the maximum of the unbound tariff distribution to be effective, $B < \tau_{max}$. Binding commitments induce a mixed discrete and continuous distribution over tariffs. A formal statement of the *bound* tariff distribution appears in the appendix. When a policy shock arrives, the new tariff is a random draw from $H(\tau')$. There is a discrete probability $H(B)$ that the tariff draw is below the binding. But with probability $1 - H(B)$, the tariff draw is above the binding and only the bound tariff rate is observed. The probability mass of extreme draws in the unbound distribution of τ are placed at the binding, thus reducing the mean and variance of tariffs.

3.2 Entry and Exit under Uncertainty

Under a stochastic tariff process, there is an option value of waiting with a structure similar to Baldwin and Krugman (1989). While the current tariff is known, future profit flows are subject to the stochastic process for tariffs. The firm's decision to enter an export market is an optimal stopping problem. Firms can be divided into exporters, state 1, and non-exporters, state 0. The value of being an exporter in the current period is V^1. A firm that is in state 1 exits only when hit by the death shock. Non-exporters hold an option value of waiting to enter in the future V^0. Non-exporters will enter a foreign market only when the value of exporting less sunk entry costs exceeds the value of waiting such that $V^1 - K_e \geq V^0$.

The decision rule for each firm is defined by the trigger tariff τ_1 that makes the firm indifferent between entry and waiting. For each firm, identified by its unit labor requirement

c, the entry trigger τ_1 implicitly solves the indifference condition

$$V^1(\tau_1) - K_e = V^0(\tau_1) \tag{6}$$

A firm will enter the export market if $\tau_t \leq \tau_1$.

The solutions for the current values of entry and waiting are derived in the appendix. The entry margin corresponds to the firm with unit labor requirement c^U that is indifferent to entry or waiting at time t.[9] For this marginal firm, the current tariff equals the entry trigger such that $\tau_t = \tau_1$. The expression in (6) defines a zero cutoff profit condition for the entry margin. I solve directly for c^U and express it in terms of an uncertainty component $\Theta(\tau_t)$ and the deterministic cutoff c^D:

$$c^U = \Theta(\tau_t) \times c^D \tag{7}$$

$$\text{where } \Theta(\tau_t) = \left[\frac{1-\beta+\beta\gamma\Delta\left(\tau_t\right)}{1-\beta+\beta\gamma}\right]^{\frac{1}{\sigma-1}} \tag{8}$$

As shown in the appendix, $\Theta(\tau_t) \leq 1$ since $\Delta(\tau_t) \leq 1$. For a given current tariff, uncertainty over the tariff generates a lower cost cutoff than a deterministic model. The productivity premium necessary to overcome this hurdle is the ratio of c^D and c^U, or $\frac{1}{\Theta}$.

The expression for $\Delta(\tau_t)$ captures the random variation in the tariff conditional on a policy shock arrival. In the appendix, I show the following:

$$\Delta\left(\tau_t\right) - 1 = \left(1 - H(\tau_t)\right)\left[\frac{E(\tau^{-\sigma} \mid \tau \geq \tau_t) - \tau_t^{-\sigma}}{\tau_t^{-\sigma}}\right] \leq 0$$

I interpret $\Delta\left(\tau_t\right) - 1$ as the expected proportional reduction in operating profits that occurs following a bad shock. The leading term $(1 - H(\tau_t))$ is the probability of a shock that exceeds the current tariff for the marginal firm. The term in brackets is the expected proportional loss in profits, starting from τ_t, if a bad shock arrives. The inequality is always strict except

[9] Superscript U denotes the "uncertain" environment in contrast the the "deterministic" environment D.

when the current tariff is at the maximum of the tariff distribution, in which case $c^D = c^U$.

Even though another policy shock could induce a new tariff that is lower than the current tariff, it is only the prospect of a bad shock that affects the decision of whether to enter today. This is an example of the "bad news" principle identified by Bernanke (1983). It holds despite the convexity of profits in tariffs. When a firm enters, it weighs the expected PDV of profits from entering today against the value of waiting for a better shock in the future. Because good news in the future is offset by the opportunity cost of entry, only bad news matters when the entry investment is irreversible.

In terms of the stochastic process for tariffs, the model includes the deterministic environment as a special case. When $\gamma = 0$, the option value of waiting vanishes. The zero cutoff profit threshold collapses to the deterministic expression in (5). In effect, making a credible commitment not to change tariffs in the future can move firms toward the solution of the deterministic problem. Lastly, since the prospect of "bad news" is a key element in a firm's entry decision, bindings play an important role by limiting losses in tariff reversals. This effect feeds through to a reduction in the firm's expected profit loss given a reversal to higher tariffs.[10]

3.3 Implications of Uncertainty for the Entry Cutoff

Uncertainty about future trade policies delays entry at the margin relative to the deterministic model. Reducing uncertainty will lead prospective firms to bring entry forward even if applied tariffs remain unchanged. Uncertainty also makes firms on the margin more cautious. For a given tariff reduction, the elasticity of the entry cutoff to changes in tariffs is attenuated by uncertainty. These results, caution and delay, can be derived analytically and have important implications for policy.[11] Detailed derivations appear in the appendix.

[10] A binding augmented version of the profit loss term $\Delta(\tau_t, B)$ is derived in the appendix.

[11] These caution and delay effects are related to similar findings for investment in studies of firm-level response to demand shocks under uncertainty (e.g. Bloom et al., 2007).

PROPOSITION 1 ***[Caution]*** *The entry cutoff c^U is less elastic with respect to a given tariff change when there is tariff uncertainty.*

PROOF:(see appendix)

The expected profit loss of a bad shock is decreasing in the current tariff τ_t. As the current tariff τ_t increases, the expected reduction in profits given a reversal grows smaller. I show in the appendix that the semi-elasticity of the profit loss term $\Delta(\tau_t)$ to tariff changes is

$$\frac{\partial \Delta(\tau_t)}{\partial \ln \tau_t} = \frac{\sigma[(1 - H(\tau_t))E(\tau^{-\sigma} \mid \tau \geq \tau_t)]}{\tau^{-\sigma}} \geq 0$$

If $\tau_t = \tau_{max}$, $\Delta(\tau_t)$ equals one, $c^U = c^D$ and the derivative goes to zero since there is no scenario worse than the present. This implies the proportion of profits lost in a tariff reversal, $\Delta(\tau_t) - 1$, is reduced.

I log differentiate the expression for c_j^U from equation (7) to obtain the elasticity

$$\begin{aligned} \varepsilon^U(\tau_t) &= \frac{d \ln c_t^D}{d \ln \tau_t} + \frac{d \ln \Theta_t}{d \ln \tau_t} \\ &= -\frac{\sigma}{\sigma - 1}\left[1 - \left(\frac{\beta\gamma}{(1 - \beta + \beta\gamma\Delta)}\left(\frac{[(1 - H(\tau_t))E(\tau^{-\sigma} \mid \tau \geq \tau_t)]}{\tau_t^{-\sigma}}\right)\right)\right]. \end{aligned}$$

The leading term is the deterministic elasticity. It is attenuated by the bracketed term, which is less than or equal to one. In absolute magnitudes $\mid \varepsilon^U(\tau_t) \mid < \mid \varepsilon^D(\tau_t) \mid$ and the responsiveness of the entry margin is reduced under uncertainty. The two exceptions (limiting cases) are when $\gamma = 0$ (i.e. tariffs are deterministic) or when τ_t is already at the maximum of the tariff distribution. In either case, the elasticity of the cutoff under uncertainty evaluated at the tariff maximum equals the elasticity at the deterministic cutoff.

Trade policy uncertainty also generates first order reductions in the entry margin. These are summarized in the following proposition.

PROPOSITION 2 ***[Delay]*** *Higher bindings or higher arrival rates of policy shocks reduce the entry cutoff, c^U, by delaying investment in market entry. In elasticity terms:*

(a) Arrival Rates

$$\varepsilon(\gamma) = \frac{d\ln c_t^U}{d\ln\gamma} = \frac{\beta\gamma}{\sigma-1}\left[\frac{1-\beta}{(1-\beta(1-\gamma))\,((1-\beta\,(1-\gamma\Delta))}\right](\Delta-1) < 0$$

(b) Bindings

$$\varepsilon(B) = \frac{d\ln c_t^U}{d\ln B} = -\frac{\sigma}{\sigma-1}\left(\frac{\beta\gamma}{(1-\beta+\beta\gamma\Delta)}\left(\frac{(1-H(B))B^{-\sigma}}{\tau_t^{-\sigma}}\right)\right) < 0$$

PROOF:(see appendix)

This proposition isolates the effects of policy shock timing and magnitudes into two components. First, increases in the arrival rate of policy shocks reduce entry. In the deterministic limit $\varepsilon(\gamma)|_{\gamma=0} = 0$ and this delay effect vanishes. The effect is independent of the form of the tariff distribution $H(\tau')$. Future tariffs could have a lower expected value than current tariffs and some firms would still delay entry. This follows from the option value of waiting. If a more favorable tariff regime is on the horizon, delaying entry may be optimal. Similarly, when current tariffs are low and expected tariffs are high, firms on the margin will wait to enter. Second, binding reductions can increase entry, even if they do not constrain the current applied tariff, by mitigating the worst case scenario and bringing entry forward. In an environment where policy shocks cannot be eliminated, lower bindings can raise trade even if the binding is above the current period applied tariff.

On the extensive margin, binding reductions could be just as effective as applied tariff reductions for increasing trade. The figurative "insurance" against backsliding through binding commitments would be relevant if prospective entrants place some probability weight on the possibility of large scale tariff reversals. In theory, further reductions in binding commitments through WTO negotiations would be meaningful. This is a testable implication of the model. Consider a current tariff τ_0 that is below its binding B_0. Suppose the current tariff and binding are changed by $d\ln\tau$ and $d\ln B$, respectively. The comparative static for a change in the entry cutoff $d \ln c^U$ is computed as follows

$$d \ln c^D = \varepsilon^U(\tau_0) d \ln \tau + \varepsilon(B_0) d \ln B \tag{9}$$

$$= \varepsilon^D(\tau_0) d \ln \tau - \varepsilon(B_0) \times (d \ln B - d \ln \tau) + r_0 \times d \ln \tau \tag{10}$$

$$\text{where } r_0 = \frac{\sigma}{\sigma - 1} \left(\frac{\beta\gamma}{(1 - \beta + \beta\gamma\Delta)} \left(\frac{(H(B_0) - H(\tau_0)) E[\tau^{-\sigma} \mid \tau \in (\tau_0, B_0)]}{\tau_0^{-\sigma}} \right) \right).$$

The first term is the deterministic elasticity. The second term captures relationship between simultaneous binding and tariff changes. If the binding is unchanged, say in a unilateral tariff reduction, then the impact on the entry cutoff is reduced. When both the binding and tariff change by the same amount, $d \ln B - d \ln \tau = 0$, the second term drops out. The third term is the residual uncertainty about tariff outcomes in the policy space between τ_0 and the binding B_0. Residual uncertainty will reduce the elasticity of the cutoff if the gap between B_0 and τ_0 is large and the probability mass in that range of the tariff distribution is high. This comparative static result is summarized in the following corollary to propositions 1 and 2.

COROLLARY 1 ***[Bound tariff changes]*** *Tariff changes accompanied by equal or greater changes in binding commitments will generate more new entry than unbound, unilateral tariff changes.*

When tariffs are reduced unilaterally, without constraining future policy makers through binding, the impact on the entry cutoff is mitigated. I confirm the broader implications of this prediction in the quantification exercise.

4 Empirical Evidence

The empirical strategy uses measures of uncertainty derived from the model to test if exporters place positive probability weight on a reversal to binding tariff level. The approach exploits the cross section variation in tariffs and bindings to model the probability that a product is traded. I use the data to address whether uncertainty over reversals to binding tariffs affects the long-run pattern of entry across industries.

4.1 Estimation Method

I estimate the model on disaggregated product data. Data on firms from a multitude of potential import partners are not available. A reasonable measure of firm entry is whether a disaggregated product is traded.[12] A method for evaluation of trade policy reforms under uncertainty with more widely available product data is a contribution of this paper.

I extend the model to multiple industries, by allowing the minimum unit cost to vary by exporter j, industry I, and time t such that $c^L_{tjI} = M_{tj} c^L_I$. As in the model, M_{tj} indexes aggregate productivity across exporters and c^L_I is the minimum unit costs of the most productive exporter in industry I. Using v to denote a product, trade is observed if the unit cost of the most productive firm in country j is below the cutoff for a particular product, specifically $c^L_j < c^U_{tjv}$.

The unit cost of the marginal firm c_{tjv} from country j in product v is not observed, but it must equal the cutoff threshold $c_{tjv} = c^U_{tj}$. The ratio of the cutoff for the marginal firm in product v to that of the most productive firm in the industry c^L_j can be defined in terms of observables as a latent variable.[13] If the expected PDV of entering today is greater than or equal to the fixed cost of entry, I observe the decision of at least one firm to enter when a product is traded. I define a latent variable Z_{tjv} for the $v-th$ product from country j as

$$Z_{tjv} = \left(\frac{c^U_{tj}}{c^L_j} \right)^{\sigma-1} = \frac{\Theta_t^{\sigma-1} \tau_{tjv}^{-\sigma} A_{tj} (c^L_{jI})^{1-\sigma}}{(1-\beta) K_{tjv}}$$

where the second equality follows from substitution of equations (7) and (5) for c^U_{tj}. If $Z_{tjv} \geq 1$

[12] The evidence of firm level entry following trade liberalizations is confirmed in disaggregated product level studies such as Kehoe and Ruhl (2009) and Debaere and Mostashari (2010). Even if firm data were available, it would be difficult to identify the set of potential exporters and estimate entry probabilities at the tariff line level for the universe of all firms.

[13] A similar cross-country latent variable formulation is used in Helpman et al. (2008).

for at least one exporter in country j, then trade is observed in that exporter-product pair.

Taking logs and substituting for Θ using equation (8) yields

$$z_{tjv} \propto -\sigma \ln \tau_{tjv} + \ln \left[\frac{1-\beta+\beta\gamma\Delta}{1-\beta+\beta\gamma} \right] + d_{tj} + d_{tI} + \varepsilon_{tjv} \tag{11}$$

where $\varepsilon_{tjv} \sim N(0, \sigma_\varepsilon^2)$ is i.i.d measurement error.

I assume that sunk export costs vary across each industry I such that $\ln K_I = k_I$. A set of exporter-year fixed effects d_{jI} and industry-year effects d_{tI}, control for unobserved variables. The exporter-year effect $d_{tj} = (1-\sigma)\ln M_{tj} + (1-\sigma)\ln w_j$ encompasses unobserved heterogeneity in aggregate productivity and wages. The industry-year effect $d_{tI} = k_I + \ln \mu_I + y_t + (\sigma-1)p_{tI} + (1-\sigma)\ln c_I^L$ combines unobserved heterogeneity in entry costs, aggregate expenditure, demand conditions from the price index, and industry minimum unit costs. Trade is observed when $z_{tjv} = \ln(Z_{tjv})$ is positive.

This specification differs from a deterministic model due to the bracketed term, which is non-linear in the parameters of interest. In the deterministic limit where $\gamma = 0$ the bracketed uncertainty term drops out entirely. Since I ultimately test for presence of uncertainty, I take $\gamma = 0$ as a testable null hypothesis and linearize around this point. The first-order Taylor approximation to $\ln \Theta_{tjv}^{\sigma-1}$ around $\gamma = 0$ is

$$\left. \frac{d \ln \Theta_{tjv}^{\sigma-1}}{d\gamma} \right|_{\gamma=0} \approx \frac{\beta\gamma}{1-\beta}(\Delta(\tau_{tjv}) - 1). \tag{12}$$

The linearized uncertainty term parsimoniously represents the two components of the uncertainty process: the magnitude of the expected proportional loss in profits given a policy shock arrives is captured by $\Delta(\tau_{tjv}) - 1$; the arrival rate of trade policy shocks appears linearly in γ. Estimation requires measures of the profit losses that could occur in a reversal.

A strength of the analytical simplicity of this model and the focus on trade policy is that measures of the expected profit loss can be constructed from tariff data. I discretize the expected loss for a reversal to the binding tariff from the applied tariff with probability

$p_B = 1 - H(\tau_{tjv})$. The discrete decomposition is

$$\Delta(\tau_{tjv}) - 1 = -p_B \frac{\tau_{tjv}^{-\sigma} - B_{tv}^{-\sigma}}{\tau_{tjv}^{-\sigma}} = -p_B U_{tjv}^B \tag{13}$$

The uncertainty measure, U_{tjv}^B, is bounded below at zero and bounded above at 1 for a reversal to total autarky. For all exporters in the sample, the applied tariff is the MFN tariff such that $\tau_{tjv} = \tau_{tv,MFN}$. For any partner and tariff line where the bound tariff is above the MFN tariff, the "binding uncertainty" measure U_{tjv}^B is positive. For example, "Windscreens of toughened (tempered) safety glass of a kind used as components in passenger motor vehicles" had a tariff of 5% at the MFN rate and 10% at the bound rate for Australia in 2004. These correspond to a profit loss of 17% for binding uncertainty (U^B) when $\sigma = 4$.

Substituting the uncertainty measure into equation (11) yields

$$z_{tjv} = -\sigma \ln \tau_{tjv} - p_B \gamma \frac{\beta}{1-\beta} U_{tjv}^B + d_{tj} + d_{tI} + \varepsilon_{tjv} \tag{14}$$

In moving from theory to data, several identifying assumption are necessary. First, I assume a common elasticity of substitution σ across industries. Second, exporters within an industry form the same expectations, using the same tariff distribution, about future policies. This is necessary to identify the probability of reversals, conditional on the current trade policy. The assumption is consistent with a rational expectations environment where there are no arbitrage opportunities.

Let T_{tjv} be a binary indicator defined as $T_{tjv} = \mathbf{1}[z_{tjv} > 0]$. I model the probability that a product is traded as $p_{tjv}^{(T=1)} = \Pr.(T_{tjv} = 1 \mid Xb) = F(Xb)$ where $F(\cdot)$ is a CDF. The estimating equation using the first-order approximation is

$$p_{tjv}^{(T=1)} = F[b_\tau^* \ln \tau_{tjv} + b_B^* U_{tjv}^B + d_{tj} + d_{tI}]. \tag{15}$$

Given the assumed normality of the errors, I could estimate a Probit model. However, there are 2267 industry-year fixed effects and estimates of these incidental parameters are potentially inconsistent, leading to bias in the parameters of interest. I assume instead that $F(\cdot)$ is linear and estimate a linear probability model (LPM) using OLS.[14]

The starred parameters (b^*_τ and b^*_B) are scaled into the marginal effects on the probability a product is traded. The estimated, unstarred coefficients can still be interpreted in the context of the model. The elasticity of sales to applied tariffs is negative and estimated by the parameter $b_\tau = -\sigma$ up to a scale factor. The negative impact of uncertainty is estimated up to scale by the parameter $b_B = \frac{\beta}{1-\beta}\gamma \cdot p_B$ where the term in discount factors is a positive constant. These coefficients are proportional to the probability weight placed on reversals to the binding, given by $\gamma \cdot p_B$. Negative coefficients indicate exporters in the average tariff line place some weight on bad news when making entry decisions.

4.2 The Application to Trade Policy in Australia

I focus on Australia, a country with a confluence of high quality data and policy variation relevant to uncertainty. In recent history, Australia maintained fairly high applied trade barriers. Unilateral liberalization means there are now large gaps between applied protection and binding commitments. These factors encompass the sources of trade policy uncertainty reviewed in the introduction. Theoretically grounded empirical estimates of the role of policy uncertainty and the interaction of various trade policy instruments for Australia should have validity in a host of outside applications and forthcoming policy negotiations.

While Australia has low applied tariffs at present, this has not been the case historically. Lloyd's (2008) careful construction of a 100 year time series for Australian tariffs shows that some sectors were highly protected as recently as the early 1990s. There was a legacy of protection for non-competitive industries and political interference in the tariff making process during the pre- and post-war period (Glezer, 1982). Gradual and, more importantly,

[14]OLS does not restrict predicted probabilities to the range $(0, 1)$ and raises heteroskedasticity issues. I have verified in unreported results that signs and significance patterns are unchanged in probit fixed effect and conditional logit specifications.

unilateral liberalization began in the late 1980s and continued into the 1990s.[15] Even in sectors with low applied tariffs, a prospective exporter in the years 2004-2006 could look back little more than a decade to justify fear of a high tariff regime.

Since higher historical tariffs were the starting point for concessions in the Uruguay Round (1986-1994) of multilateral negotiations (see Corden, 1996), Australia's binding commitments today are high and dispersed.[16] Although applied tariffs are at or near zero in many products, the maximum bound rates range from zero to 55 percent. This variation in the binding gap between applied and bound rates is exploited empirically. Importantly, Australia abolished quotas and removed most other quantitative import restrictions in a process known as "tariffication" as part of its Uruguay Round concessions (Snape et al. 1998). Measurement of trade barriers is mostly homogeneous across products. The effective rate of domestic industry assistance has been constant at about 5% since the late 1990s (Productivity Commision, 2010, p. 48).

Australia's own Productivity Commission recently noted the prevention of "backsliding" on liberalization as a potential benefit of preferential trade agreements. In their comprehensive review of Australia's trade agreements, the Commission notes that "…even where agreements do not result in a reduction in existing barriers, they can be used to lock in current policies, restricting countries from increasing barriers in the future…in many instances applied tariffs may be low, or even zero, but bound tariff levels might be quite high, and there is a risk that applied tariffs could be increased up to bound levels" (2010, p. 87).

As a case in point, if Australia were to revert all tariffs to their bindings this would substantially shift the tariff profile. In 2004, only 24% of Australia's MFN tariffs are equal to the binding tariff commitment. The magnitude of changes in a reversal to bindings can be large. As the histogram in Figure 1 shows, nearly 73% of MFN tariffs could increase,

[15] Coincidentally, journalist Paul Kelly titled his exhaustive book documenting the economic and political upheaval of these reforms "The End of Certainty."

[16] Policy makers in Australia had adopted a so-called "midway" position in multilateral negotiations. Australia maintained it was neither a developing nor a fully industrialized country and required the flexibility to impose tariffs to protect infant industries with cost disadvantages (Snape et al. 1998).

some by up to 35% in the worst case scenario. Were such a reversal to occur in 2004, an exporter in the average tariff line could see his profits reduced by 19%. As Figure 2 shows, the profit losses extend to nearly all product lines. A full reversal to bindings would shift the distribution of profits down substantially relative to the level at applied tariffs in 2004.[17]

4.3 Data Implementation and Sample

A description of the data sources appears in the appendix. I focus here on construction of the regression samples, tariffs and uncertainty measures.

I begin with annual import data at the 10-digit level of detail for Australia from 2004 and 2006. There are 8,179 products that are potentially tradable and these are matched to product specific tariff lines.[18] These product classifications are extremely detailed. For instance, Australian customs tracks 67 different varieties of tubes and pipes. If I break the data down to its nuts and bolts, literally, I find there are ten different varieties of bolts, which can be fastened with two types of nuts.

The data encompass the entire population of potential importers whether a good is traded or not. Because I know there is heterogeneity at the industry level, I control for industry-year fixed effects at the 4-digit Heading level of the Harmonized System. I then estimate the model on a pooled cross-section in 2004 and 2006.

The tariff line measure of the ad valorem applied tariff (i.e. 1+ tariff rate) is the MFN rate offered to all WTO members. A large number of developing country exporters are eligible for preferences under one or more programs in addition to the MFN tariff. Utilization of these preferential tariffs is not 100% and requires additional documentation and compliance costs (Pomfret et al., 2010). I exclude all countries from the sample that are eligible for unilateral preferences such as the Generalized System of Preferences even though not all tariff lines are covered under these regimes. Since my objective is to estimate the impact of reversals from

[17] I compute the percentage profit reductions from the uncertainty measures derived in the preceding empirical section.

[18] I correct the product classification for codes that are added, dropped or changed during the sample period by the Australian Bureau of Statistics.

applied MFN tariffs to binding tariffs for WTO members, I excluded all trade partners that have bilateral PTAs.[19] This restriction excludes New Zealand in 2004 and 2006 along with Thailand, Singapore and the United States in 2006.[20]

The uncertainty measures of the expected loss from reversals to the binding (U_B) are constructed using the theoretical structure above. Using data on MFN applied tariffs and bindings, I construct the uncertainty measures in equation (13) for parameterizations of the elasticity of substitution ($\sigma \in \{3, 4, 5\}$). I assume $\sigma = 4$ in my baseline estimates, but show these are robust to the choice of σ.[21]

I define an industry by the HS4 Heading of a product variety, resulting in 1243 possible industries. All final specifications include exporter-year and industry-year fixed effects to control for several sources of heterogeneity in the estimating equation (15). A critical factor to control for in this application as the relative productivity difference between exporters in each industry. However, because many countries trade no products within an HS4 defined industry, they are perfectly predicted by these fixed effects and are dropped from the regression sample. This leaves 2267 industry-year fixed effects in the regression sample and I cluster standard errors at this level.

The final sample contains 600,970 exporter-product observations for the years 2004 and 2006. Table 1 reports summary statistics. Within the sample, the average applied tariffs are low at approximately 4.5 and 3.8 log percentage points in 2004 and 2006. The average potential loss in profits from binding uncertainty is over 20% *per annum.*

4.4 Product Regressions – Baseline

The baseline linear probability estimates appear in Table 2. Estimated coefficients from the baseline model appear in column 2. They conform with the predictions from theory. The

[19]Evidence from Handley and Limão (2011) suggests these PTAs provide increased security of preferential tariffs and would contaminate my results.

[20]In unreported results, I verify that the baseline estimates are robust to dropping Thailand, Singapore and the U.S. from the sample in 2004 as well.

[21]Bernard et al. (2003) estimate that $\sigma = 3.8$ using U.S. firm level trade data.

coefficients on the applied tariff and uncertainty measures are negative and significant.[22] For comparison, I run a naive model containing only tariffs and fixed effects as regressors in column 1. Since tariffs are positively correlated with the uncertainty measure, omitting uncertainty imparts a downward bias to the tariff coefficient in column 1.

It is possible that other types of protection are driving these results. In all regressions, I include a binary indicator for a positive MFN tariff at the tariff line level. Australia's current tariff profile tends to have zero tariffs in products that are not produced domestically or less frequently imported. Where there is both domestic production and import competition, positive tariffs are levied. Failure to control for this confounds the effect of tariff protection on exporting with policymakers' motive to protect import-competing sectors. Some lines are subject to non-tariff barriers (NTBs) and these forms of protection could bias my results if Australia substitutes NTB protection for applied protection near the binding. I use the ad-valorem equivalent NTB measures from Kee et al. (2009) to construct additional controls. Because these measures have no time variation, I interact them with a year indicator. These NTBs slightly reduce the probability a product is traded, but they are not significant in column 3. A small fraction of tariff lines levy some mixture of specific and ad-valorem tariffs; I include tariff line indicators for these "complex" tariffs in column 4 of Table 2 interacted with year indicators. The added variable is insignificant and does not change the main results.

4.5 Quantification

4.5.1 Elasticities

The first-order approximation used to compute the uncertainty terms decouples the elasticity on applied tariffs from the uncertainty measure. In order to measure and test the cautionary effects derived in Proposition 1 and elaborated in the Corollary, I need to account for the

[22]Bindings are set at the 6 digit sub-heading level of the Harmonized System and do not change through time during the sample. I have verified in unreported results that the results are robust to clustering standard errors at the 6 digit level rather than the HS4*year level.

fact that the uncertainty measure is a function of tariff and binding levels. The elasticity of entry to tariff and binding changes is computed by log differentiation of the uncertainty measure. In terms of the model, the estimated elasticity of product entry to tariff reductions, $e(\tau)$ is the sum of the direct effect to current profits, the first term in (15), and the change to future profits if a reversal occurs, the second term in (15):

$$\begin{aligned} e(\tau) &= b_\tau + b_B \frac{\partial U^B_{tjv}}{\partial \tau} \tau_{tjv} \\ &= b_\tau - b_B \sigma \times \frac{B^{-\sigma}_{tv}}{\tau^{-\sigma}_{tjv}} \\ &= -\sigma \left[1 - \gamma p_b \frac{\beta}{1-\beta} (1 - U^B_{tjv}) \right]. \end{aligned} \tag{16}$$

This is simply the first order approximation to the cautionary effect derived in Proposition 1.[23] The elasticity of entry to applied tariff changes will depend on the probability of reversals, $\gamma \cdot p_B$, and their proportional magnitudes $B^{-\sigma}/\tau^{-\sigma} = 1 - U^B$.

Proposition 2 shows that the elasticity of entry is reduced by increases in bindings. I can also use the empirical model structure to obtain the elasticity of entry to changes in binding levels following the same computation as above:

$$\begin{aligned} e(B) &= b_B \frac{\partial U^B_{tjv}}{\partial B} B_{tv} = -b_B \sigma \times \frac{B^{-\sigma}_{tv}}{\tau^{-\sigma}_{tjv}} \\ &= -\sigma \gamma p_b \frac{\beta}{1-\beta} (1 - U^B_{tjv}) < 0. \end{aligned} \tag{17}$$

The elasticity of entry to binding changes and the cautionary effect from above are symmetric. If bindings are reduced by the same percentage as applied tariffs, the cautionary effect is exactly offset "as if" tariffs were deterministic. This result follows from the Corollary to Propositions 1 and 2.

To compare the impact of reducing bindings versus unilaterally reducing applied tariffs,

[23] In the approximation, it is not assured that the term in brackets is less than one, as in the theoretical model, since $\frac{\beta}{\beta-1} > 1$ whenever $\beta > 0.5$. Nevertheless, the estimates from the econometric model below do satisfy this restriction in practice.

I turn to the lower panel of Table 2. Caution and delay effects are large and evident after I compute the elasticities at the mean of the uncertainty measure using expressions (16) and (17). The elasticity of entry to tariff reductions is reduced from 23 percent to 14 percent, a reduction of over 40 percent due to the cautionary effect. When uncertainty is present, the responsiveness of entry to tariff reductions is substantially mitigated by caution. Delay effects are also important. The elasticity of the probability of being traded increases by 9 percent for every 1 percent decrease in bindings. At the mean of binding uncertainty, for every 1 percentage point reduction in *applied* tariffs the same effect can be achieved by a 1.5 percentage point reduction in binding commitments not to raise tariffs in the future.

4.5.2 Policy Evaluation

The exporter-year and industry-year effects absorb a large share of total variation in the pattern of traded goods. This is not surprising given the well-known, traditional roles of technology driven comparative advantage, distance, exchange rates, transport costs and endowment differences in predicting the pattern of trade. Nevertheless, most of these factors cannot be directly influenced by trade policy, even over the long run. I focus on comparing the relative impacts of alternative trade policy instruments. I will show that in some scenarios the aggregate impact of trade policy uncertainty is substantial.

I use the econometric model to compare the scope for new product creation given the margins of policy adjustment available to Australia in 2004 and 2006. Using the elasticities in (16) and (17), the total derivative of the regression equation is

$$\mathrm{d}Pr(T_{tjv} = 1) = b_\tau \mathrm{d}\ln\tau - b_B\sigma(1 - U^B_{tjv})\mathrm{d}\ln\tau + b_B\sigma(1 - U^B_{tjv})\mathrm{d}\ln B. \tag{18}$$

I consider a policy experiment in which Australia jointly reduces all applied tariffs and bindings to zero. I compute the total number of traded products as the sum of the changes in the predicted probability a product is traded over the entire sample.[24] I use the actual

[24]A similar quantification exercise is used by Debaere and Mostashari (2010) in a different context.

levels of applied tariffs and bindings in the data. If a product already has a tariff and binding of zero, then no new products will be predicted by the policy changes. Alternatively, in products with positive tariffs, binding uncertainty or both, the predicted change in the probability a product is traded will depend on levels of the initial policy. The sum total of new products can be decomposed into three policy changes:

Total Products	**Policy Change**
(A) setting all applied tariffs to zero under uncertainty	$d\ln\tau = \ln\tau_{tjv} - 0$
$\sum_{j=1,v=1}^{J\times V}\{[b_\tau - b_B\sigma \times (1-U_{tjv}^B)]\ln\tau_{tjv}\}$	
(B) reducing bindings to the level current applied tariffs	$d^B\ln B =$
$\sum_{j=1,v=1}^{J\times V}\{b_B\sigma \times (1-U_{tjv}^B)](\ln B_{jv} - \ln\tau_{tjv})\}$	$\ln B_{tjv} - \ln\tau_{tjv}$
(C) reducing bindings from current applied tariffs to zero	$d^C\ln B = \ln\tau_{tjv}$
$\sum_{j=1,v=1}^{J\times V}\{b_B\sigma \times (1-U_{tjv}^B)]\ln\tau_{tjv}\}$	
Grand Total of A, B and C	$d\ln\tau = \ln\tau_{tjv}$,
$\sum_{j=1,v=1}^{J\times V}\{b_\tau \times \ln\tau_{tjv} + b_B\sigma \times (1-U_{tjv}^B)(\ln B_{tjv} - \ln\tau_{tjv})\}$	$d\ln B = \ln B_{tjv}$

For each year t, I compute the total effect of each policy experiment above. For policy A, reducing applied tariffs to zero, the caution effect comes in directly in the second term, which reduces the overall impact of the tariff reduction under uncertainty. In the next experiment, policy B, bindings are reduced to the level of applied tariffs, which removes the motive to delay investment at current tariffs. This is the effect of removing delay at current tariffs. Policies A and B can be implemented independently, but would leave a margin for new product creation on the table. To see this, note that the grand total of new products generated by reducing bindings and applied tariffs to zero is the empirical counterpart to the Corollary of Proposition 1 and 2 showing that tariff elasticities are larger when accompanied by equal or greater changes in bindings. Total products from removing the caution effect and committing to free trade is the grand total net of products generated by policies A and B.

In 2006, the model predicts a 4.9% increase in traded products if Australia were to set all its remaining positive MFN tariffs to zero on a unilateral basis. Alternatively, Australia could reduce all bindings to current applied tariffs, eliminating the risk of future "bad news." This action would increase the number of traded products by 4.1 percent in 2006. The remarkable aspect of this effect is that not a single *applied* policy measure would need to change. Merely the commitment never to raise tariffs would generate a an increase in traded products with MFN partners. Lastly, bindings could be further reduced to zero in conjunction with the reduction of MFN tariffs to zero. This would generate an additional 2.7 percent increase in traded products in 2006. This additional product growth arises from the complementarity of reducing tariffs and securing those reductions so that the caution effect does not attenuate the response of entry.

The predicted growth in the number of traded products varies by year and policy experiment because applied tariffs are slightly lower in 2006 than in 2004. When comparing years it is also informative to look at the share of growth for each policy change relative to the total growth achieved by setting bindings and tariffs to zero simultaneously. More than half of the potential new product growth is accounted for by removing uncertainty. Reducing bindings to applied tariffs accounts for about one third of growth and removing caution accounts for about one quarter of total growth. In contrast, less than half of the potential new product growth is achieved by unsecured, unilateral MFN tariff reductions.

While some predicted effects appear to be quite large, it is also possible these product measures actually understate the true level of entry by firms. There is undoubtedly within product firm entry. If a product is already traded or becomes traded due to the policy change, entry by more than one firm is counted only once. But whether the estimates over- or understate the true impact is less relevant when evaluating the relative efficacy of reducing unilateral applied tariffs versus reducing uncertainty. As long the predictions are not systematically skewed toward applied protection or uncertainty, the relative contribution of uncertainty reductions are at least as effective as tariff reductions.

4.6 Robustness

4.6.1 Parameterization of Uncertainty Measures

The uncertainty measure requires a parametric assumption about the elasticity of substitution given by σ. The strength of using the model based measure is that it has a clear interpretation in going from the model to the regression specifications. Results could be sensitive to the assumption that the elasticity of substitution is $\sigma = 4$ when constructing the measures. Table 4 reports the results across values of σ with the baseline specification included for easy comparison in column 2. Signs and significance are largely unchanged. Moving from high to low values of σ tends to increase the magnitude of estimated coefficients on the uncertainty measures.

4.6.2 Reduced-Form Specification

The model makes reduced-form predictions about the elasticity of entry to bindings that can be used to avoid parameterization of the uncertainty measures. I regress the traded product indicator on logs of applied tariffs, bindings and their interaction. Results with log levels of tariffs and bindings appear in Table 5. The elasticity of entry to the binding is negative and significant. To capture the caution effect, I include an interaction term for tariffs and bindings in column 2. The positive and significant coefficient on the interaction indicates that caution is present in the reduced form specification as well. These results show that the sign pattern and significance in the baseline regression are not driven by applied tariffs appearing non-linearly in the uncertainty measure, nor is non-linearity in bindings driving the results.

5 Conclusion

Trade policy is inherently uncertain. Multilateral policy commitments at the WTO are meant to provide a more secure and stable trade policy regime for prospective exporters. I capture these elements in a tractable model of export market entry patterns under uncertainty and test its predictions empirically. Evidence from Australia suggests that prospective exporters place weight on the possibility of trade policy reversals to bindings. This leads to delay of the entry decision and less responsiveness on the entry margin to trade policy changes. I find that multilateral policy commitments at the WTO help to reduce this uncertainty and increase product entry. Within the space of trade policy tools available, policy commitments could generate as much product entry as unilateral tariff reductions. These results are important for both quantifying the value and modeling the impact of tariff binding commitments at the WTO. The evidence of greater product entry in tariff lines with lower bindings, a key policy instrument for guaranteeing predictable market access, indicates that these commitments are valuable to exporters.

These findings point to an important and broad role for the WTO and international institutions in the monitoring and enforcement of multilateral commitments. For bindings to be effective, exporters must believe that penalties for violating the commitments would be costly enough that they would either never occur or be swiftly reversed. The evidence that lower bindings increase product entry for Australia suggests they are credible, but this might vary by country. To that extent, the WTO could play an important role in monitoring and enforcement of multilateral agreements on services, investment and intellectual property.

Extending and verifying these results with a broader group of countries and applications outside of international trade is important. Fortunately, the methodology developed here, which uses product data and model-based policy uncertainty measures, can be applied more broadly within international trade applications and to other forms of policy uncertainty. An important extension is the impact of trade policy uncertainty on foreign direct investment where sunk costs of opening a production facility may be even higher. Trade policy uncertainty takes many other forms in the world trade system. Modeling and testing the risk of non-renewal in preferential tariff programs, temporary trade bans, economic sanctions and the risk of anti-dumping measures are all subjects for future work.

References

Amador, M. and Bagwell, K. (2011). The Theory of Optimal Delegation With An Application To Tariff Caps. Working paper, Stanford University.

Baldwin, R. and Krugman, P. (1989). Persistent trade effects of large exchange rate shocks. *The Quarterly Journal of Economics*, 104(4):635–54.

Bchir, H., Jean, S., and Laborde, D. (2005). Binding overhang and tariff-cutting formulas. Working Papers 2005-18, CEPII research center.

Bernanke, B. S. (1983). Irreversibility, uncertainty, and cyclical investment. *The Quarterly Journal of Economics*, 98(1):85–106.

Bernard, A. B., Eaton, J., Jensen, J. B., and Kortum, S. (2003). Plants and productivity in international trade. *American Economic Review*, 93(4):1268–1290.

Beshkar, M., Bond, E., and Rho, Y. (2011). Tariff Binding and Overhang: Theory and Evidence. Working paper, University of New Hampshire.

Bloom, N., Bond, S., and Reenen, J. V. (2007). Uncertainty and investment dynamics. *Review of Economic Studies*, 74(2):391–415.

Buono, I. and Lalanne, G. (2012). The effect of the Uruguay round on the intensive and extensive margins of trade. *Journal of International Economics*, 86(2):269 – 283.

Chaney, T. (2008). Distorted Gravity: The Intensive and Extensive Margins of International Trade. *American Economic Review*, 98(4):1707–21.

Corden, W. M. (1996). Protection and liberalisation in Australia and abroad. *Australian Economic Review*, 114:141–154.

Das, S., Roberts, M. J., and Tybout, J. R. (2007). Market entry costs, producer heterogeneity, and export dynamics. *Econometrica*, 75(3):837–873.

Debaere, P. and Mostashari, S. (2010). Do tariffs matter for the extensive margin of international trade? An empirical analysis. *Journal of International Economics*, 81(2):163–169.

Dixit, A. K. (1989). Entry and exit decisions under uncertainty. *Journal of Political Economy*, 97(3):620–38.

Evenett, S. (2007). Reciprocity and the Doha Round Impasse: Lessons for the Near Term and After. Policy Insight 11, Center for Economic Policy Research.

Francois, J. F. and Martin, W. (2004). Commercial policy variability, bindings, and market access. *European Economic Review*, 48(3):665–679.

Glezer, L. (1982). *Tariff Politics: Australian Policy-Making 1960-1980*. Melbourne University Press, Carlton, Victoria.

Handley, K. and Limão, N. (2012). Trade and Investment under Policy Uncertainty: Theory and Firm Evidence. NBER Working Papers 17790, National Bureau of Economic Research, Inc.

Hassett, K. A. and Metcalf, G. E. (1999). Investment with Uncertain Tax Policy: Does Random Tax Policy Discourage Investment? *Economic Journal*, 109(457):372–93.

Helpman, E., Melitz, M., and Rubinstein, Y. (2008). Estimating trade flows: Trading partners and trading volumes. *The Quarterly Journal of Economics*, 123(2):441–487.

Kee, H. L., Nicita, A., and Olarreaga, M. (2009). Estimating Trade Restrictiveness Indices.

Economic Journal, 119(534):172–199.

Kehoe, T. J. (2005). An evaluation of the performance of applied general equilibrium models of the impact of NAFTA. In Kehoe, T. J., Srinivasan, T. N., and Whalley, J., editors, *Frontiers in Applied General Equilibrium Modeling*, chapter 13, pages 341–377. Cambridge University Press, Cambridge, UK.

Kehoe, T. J. and Ruhl, K. J. (2009). How important is the new goods margin in international trade? Staff Report 324, Federal Reserve Bank of Minneapolis.

Lloyd, P. (2008). 100 Years of Tariff Protection in Australia. *Australian Economic History Review*, 48(2):99–145.

Maggi, G. and RodriguezClare, A. (1998). The Value of Trade Agreements in the Presence of Political Pressures. *Journal of Political Economy*, 106(3):574–601.

Mattoo, A. and Subramanian, A. (2008). Multilateralism beyond Doha. Peterson Institute Working Paper Series WP08-8, Peterson Institute for International Economics.

Melitz, M. J. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica*, 71(6):1695–1725.

Messerlin, P. A. (2008). Walking a Tightrope: World Trade in Manufacturing and the Benefits of Binding. Policy brief, German Marshall Fund of the United States.

Pomfret, R., Kaufmann, U., and Findlay, C. (2010). Are Preferential Tariffs Utilized? Evidence from Australian Imports, 2000-9. Working paper, School of Economics, University of Adelaide.

Productivity Commission (2010). *Bilateral and Regional Trade Agreements*. Research Report, Canberra.

Roberts, M. J. and Tybout, J. R. (1997). The decision to export in colombia: An empirical model of entry with sunk costs. *American Economic Review*, 87(4):545–64.

Rodrik, D. (1991). Policy uncertainty and private investment in developing countries. *Journal of Development Economics*, 36(2):229–242.

Rose, A. K. (2004). Do We Really Know That the WTO Increases Trade? *American Economic Review*, 94(1):98–114.

Sala, D., Schröder, P. J. H., and Yalcin, E. (2010). Market Access Through Bound Tariffs. *Scottish Journal of Political Economy*, 57(s1):272–289.

Snape, R., Gropp, L., and Luttrell, T. (1998). *Australian Trade Policy 1965-1997: a documentary history*. Allen and Unwin, St. Leonards, NSW.

Subramanian, A. and Wei, S.-J. (2007). The WTO promotes trade, strongly but unevenly. *Journal of International Economics*, 72(1):151–175.

Tang, M.-K. and Wei, S.-J. (2009). The value of making commitments externally: Evidence from WTO accessions. *Journal of International Economics*, 78(2):216–229.

A Appendix

A.1 CDF of bound tariff distribution

The observed tariff in the bound regime τ_B is censored at the binding rate of B.

$$\tau_B = \begin{cases} \tau & \text{if } \tau \leq B \\ B & \text{if } \tau > B. \end{cases}$$

The CDF of τ_B is $H_{\tau_B}(\tau_B) = pH_1(\tau) + (1-p)H_2(\tau)$. Where $p = H(B)$ and

$$H_1(\tau) = \begin{cases} \frac{H(\tau)}{H(B)} & \text{if } \tau \leq B \\ 1 & \text{if } \tau > B, \end{cases} \quad \text{and } H_2(\tau) = \begin{cases} 0 & \text{if } \tau \leq B \\ 1 & \text{if } \tau > B. \end{cases}$$

A.2 Value functions and stochastic cutoff condition

Four equations define the initial problem at time t of a firm with unit labor requirement c. For clarity of exposition, I drop the country of origin subscripts. The value of exporting is

$$V^1(\tau_t) = \pi(\tau_t) + \beta[\underbrace{(1-\gamma)V^1(\tau_t)}_{\text{No Shock}} + \underbrace{\gamma EV^1(\tau')}_{\text{Shock Arrives}}]. \tag{19}$$

Following a policy shock, the *ex-ante* expected value of exporting following a policy change to a new tariff τ' is

$$EV^1(\tau') = E\pi(\tau') + \beta[(1-\gamma)EV^1(\tau') + \gamma EV^1(\tau')] \tag{20}$$

In time period t, the unconditional expected value of being an exporter next period given that a policy shock arrives is $EV^1(\tau')$ in (20). This expectation is time invariant because I assume that the distribution of future tariffs $H(\tau')$ is time invariant. Equation (20) can be solved explicitly for $EV^1(\tau')$ to obtain

$$EV^1(\tau') = \frac{E\pi(\tau')}{1-\beta}.$$

The resulting time invariance of $EV^1(\tau')$ does not mean that the value of exporting is time invariant. $V^1(\tau_t)$ is a function of the current tariff and firms can re-compute it on an *ex-post* basis following every tariff policy change.

The value of waiting is

$$V^0(\tau_t) = 0 + \beta[\underbrace{(1-\gamma)V^0(\tau_t)}_{\text{No Shock}} + \underbrace{\gamma(1-H(\tau_1))V^0(\tau_t)}_{\text{Shock Above Trigger}} + \underbrace{\gamma H(\tau_1)(EV^1(\tau_1 \mid \tau \leq \tau_1) - K_e)}_{\text{Shock Below Trigger}}] \tag{21}$$

Conditional on waiting until the tariff falls below the entry trigger, the expected value of exporting is

$$EV^1(\tau_1 \mid \ \tau \le \tau_1) = E\pi(\tau' \mid \tau' < \tau_1) + \beta[(1-\gamma)EV^1(\tau_1 \mid \tau_t \le \tau_1) + \gamma EV^1(\tau')] \tag{22}$$

This equation is structurally the same as (19), but it is evaluated *ex-ante* to obtain the expected value of exporting to a firm that delays entry until a more favorable policy shock arrives. If a firm waits to enter in the current period, it must be the case that current tariff exceeds the entry trigger, $\tau_t > \tau_1$.

The set of four equations (19),(20),(21), and (22) is a linear system in the four quantities $V^1(\tau_t)$,$EV^1(\tau')$, $V^0(\tau_t)$, and $E[V^1(\tau_1 \mid \tau \le \tau_1)]$ and can be solved explicitly. The solution to the set of equations is

$$V^1(\tau_t) = \frac{\pi(\tau_t)[1-\beta(1-\gamma E[\pi(\tau')])]}{[1-\beta(1-\gamma)](1-\beta)} \tag{23}$$

$$EV^1(\tau') = \frac{E[\pi(\tau')]}{1-\beta} \tag{24}$$

$$V^0(\tau_t) = \beta\gamma H(\tau_1)\frac{(1-\beta)E[\pi(\tau') \mid \tau' < \tau_1] - \beta\gamma E[\pi(\tau')] - (1-\beta)[1-\beta(1-\gamma)]K_e}{[1-\beta(1-\gamma)][1-\beta(1-\gamma H(\tau_1))]} \tag{25}$$

$$EV^1(\tau_1 \mid \tau < \tau_1) = \frac{\beta\gamma E[\pi(\tau')] - E[\pi(\tau') \mid \tau' < \tau_1](1-\beta)}{(1-\beta+\beta\gamma)(1-\beta)} \tag{26}$$

The entry margin corresponds to the firm with unit labor requirement c^U that is just indifferent to entry or waiting at time t. For this marginal firm, the current tariff equals the entry trigger such that $\tau_t = \tau_1$. Equations (23) and (25) for the value of exporting today versus waiting can be substituted into indifference condition (6) to obtain the cutoff condition in the main text.

A.3 Profit Loss Term $\Delta(\tau_t)$

A.3.1 $\Delta(\tau_t) \le 1$

I denote the maximum tariff by τ_{max}.

$$\begin{aligned}
\Delta(\tau_t) &= \left[E(\tau^{-\sigma}) + H(\tau_t)[\tau_t^{-\sigma} - E(\tau^{-\sigma} \mid \tau \le \tau_t)]\right]/\tau_t^{-\sigma} \\
&= \left[\int_1^{\tau_{max}} \tau^{-\sigma} dH(\tau) + H(\tau_t)\tau_t^{-\sigma} - \int_1^{\tau_t} \tau^{-\sigma} dH(\tau)\right]/\tau_t^{-\sigma} \\
&= \left[\int_{\tau_t}^{\tau_{max}} \tau^{-\sigma} dH(\tau) + H(\tau_t)\tau_t^{-\sigma}\right]/\tau_t^{-\sigma} \\
&= \left[(1-H(\tau_t))E(\tau^{-\sigma} \mid \tau \ge \tau_t) + H(\tau_t)\tau_t^{-\sigma}\right]/\tau_t^{-\sigma}
\end{aligned}$$

Then to show that $\Delta(\tau_t) \leq 1$, I take the difference D of the numerator and denominator in the final line above

$$\begin{aligned} D &= \left[(1 - H(\tau_t))E(\tau^{-\sigma} \mid \tau \geq \tau_t) + H(\tau_t)\tau_t^{-\sigma}\right] - \tau_t^{-\sigma} \\ &= (1 - H(\tau_t))[E(\tau^{-\sigma} \mid \tau \geq \tau_t) - \tau_t^{-\sigma}] \\ &\leq 0 \end{aligned}$$

The inequality follows because $\tau_t^{-\sigma}$ is always greater than $E(\tau^{-\sigma} \mid \tau > \tau_t)$. When the current tariff is at the maximum of the support of $H(\tau)$ such that $\tau_t = \tau_h$, then the difference in brackets and the term $(1 - H(\tau_t))$ are both zero.

A.3.2 Derivation of $\Delta(\tau_t, B)$ when tariffs are bound.

$$\begin{aligned} \Delta(\tau_t) &= \left[E(\tau^{-\sigma}) + H(\tau_t)[\tau_t^{-\sigma} - E(\tau^{-\sigma} \mid \tau \leq \tau_t)]\right] / \tau_t^{-\sigma} \\ &= \left[(1 - H(B))B^{-\sigma} + \int_1^B \tau^{-\sigma} dH(\tau) + H(\tau_t)\tau_t^{-\sigma} - \int_1^{\tau_t} \tau^{-\sigma} dH(\tau)\right] / \tau_t^{-\sigma} \\ &= \left[(1 - H(B))B^{-\sigma} + \int_{\tau_t}^B \tau^{-\sigma} dH(\tau) + H(\tau_t)\tau_t^{-\sigma}\right] / \tau_t^{-\sigma} \\ &= \frac{(1 - H(B))B^{-\sigma} + [H(B) - H(\tau_t)]E(\tau^{-\sigma} \mid \tau_t < \tau < B) + H(\tau_t)\tau_t^{-\sigma}}{\tau_t^{-\sigma}} \end{aligned} \tag{27}$$

A.4 Proofs of Propositions 1 and 2

PROPOSITION 1 ***[Caution]*** *The entry cutoff c^U is less elastic with respect to tariff changes in the stochastic model relative to once-and-for-all deterministic tariff changes.*

PROOF:

As described in the main text, the proof consists of two parts. First, I show that the expected profit loss of a bad shock is decreasing in the current tariff τ_t. Second, I show the stochastic elasticity is proportionally less than the deterministic elasticity.

(1) $\frac{\partial \Delta(\tau_t)}{\partial \tau_t} \geq 0$ implies the proportion of profits lost in a tariff reversal, $\Delta(\tau_t) - 1$, is reduced as tariffs increase.

$$\begin{aligned} \frac{\partial \Delta(\tau_t)}{\partial \tau_t} &= \tau_t[-\tau_t^{-\sigma} h(\tau_t) + h(\tau_t)\tau_t^{-\sigma} - \sigma H(\tau_t)\tau_t^{-\sigma-1}]/\tau_t^{-\sigma} + \tau_t[(1 - H(\tau_t))E(\tau^{-\sigma} \mid \tau \geq \tau_t) + H(\tau_t)\tau_t^{-\sigma}](\\ &= \tau_t[-\sigma H(\tau_t)\tau_t^{-1}] + \sigma\tau^{\sigma}[(1 - H(\tau_t))E(\tau^{-\sigma} \mid \tau \geq \tau_t) + H(\tau_t)\tau_t^{-\sigma}] \\ &= \sigma\tau^{\sigma}[-H(\tau_t)\tau_t^{-\sigma} + (1 - H(\tau_t))E(\tau^{-\sigma} \mid \tau \geq \tau_t) + H(\tau_t)\tau_t^{-\sigma}] \\ &= \sigma\tau^{\sigma-1}[(1 - H(\tau_t))E(\tau^{-\sigma} \mid \tau \geq \tau_t)] \\ &= \sigma[(1 - H(\tau_t))E(\tau^{-\sigma} \mid \tau \geq \tau_t)]/\tau^{-\sigma} \end{aligned}$$

In semi-elasticity terms, this becomes

$$\frac{\partial \Delta(\tau_t)}{\partial \ln \tau_t} = \frac{\sigma[(1-H(\tau_t))E(\tau^{-\sigma} \mid \tau \geq \tau_t)]}{\tau^{-\sigma}} \geq 0$$

(2) Using the expression for c_j^U from in equation (7), I log differentiate and derive the elasticity

$$\begin{aligned}
\varepsilon^U(\tau_t) &= \frac{d \ln c_t^D}{d \ln \tau_t} + \frac{d \ln \Theta_t}{d \ln \tau_t} \\
&= -\frac{\sigma}{\sigma-1} + \frac{1}{\sigma-1}\left(\frac{\beta\gamma}{(1-\beta+\beta\gamma\Delta)} \frac{d\Delta_t}{d \ln \tau_t}\right) \\
&= -\frac{\sigma}{\sigma-1}\left[1-\left(\frac{\beta\gamma}{(1-\beta+\beta\gamma\Delta)}\left(\frac{[(1-H(\tau_t))E(\tau^{-\sigma} \mid \tau \geq \tau_t)]}{\tau_t^{-\sigma}}\right)\right)\right] \\
&= -\frac{\sigma}{\sigma-1} \times \phi(\tau_t) \\
&= \varepsilon^D(\tau) \times \phi(\tau_t)
\end{aligned}$$

The term in brackets, represented by $\phi(\tau_t)$, is less than or equal to one. Therefore, in absolute values $\mid \varepsilon^U(\tau_t) \mid < \mid \varepsilon^D(\tau_t) \mid$. ■

PROPOSITION 2 ***[Delay]*** *Higher bindings or higher arrival rates of policy shocks reduce the entry cutoff by delaying investment in market entry. In elasticity terms:*

(a) Arrival Rates

$$\varepsilon(\gamma) = \frac{d \ln c_t^U}{d \ln \gamma} = \frac{d \ln \Theta_t}{d \ln \gamma} = \frac{\beta\gamma}{\sigma-1}\left[\frac{1-\beta}{(1-\beta(1-\gamma))\left((1-\beta\left(1-\gamma\Delta\right)\right)}\right](\Delta-1) < 0$$

(b) Bindings

$$\varepsilon(B) = \frac{d \ln c_t^U}{d \ln B} = \frac{d \ln \Theta_t}{d \ln B} = -\frac{\sigma}{\sigma-1}\left(\frac{\beta\gamma}{(1-\beta+\beta\gamma\Delta)}\left(\frac{(1-H(B))B^{-\sigma}}{\tau_t^{-\sigma}}\right)\right) < 0$$

PROOF:

(a) Log differentiating the cutoff under uncertainty with respect to γ, I obtain

$$\begin{aligned}
\frac{d \ln c_t^U}{d \ln \gamma} &= \frac{\gamma}{\sigma-1}\left(\frac{d}{d\gamma}\ln(1-\beta\left(1-\gamma\Delta\right)) - \frac{d}{d\gamma}\ln\left(1-\beta(1-\gamma)\right)\right) \\
&= \frac{\beta\gamma}{\sigma-1}\left[\frac{1-\beta}{(1-\beta(1-\gamma))\left((1-\beta\left(1-\gamma\Delta\right)\right)}\right](\Delta-1)
\end{aligned}$$

We thus have

$$\text{sgn}\left(\frac{d \ln c_t^U}{d\gamma}\right) = \text{sgn}\left(\frac{\Delta-1}{\left((1-\beta\left(1-\gamma\Delta\right)\right)}\right) < 0$$

which is negative since $\Delta - 1 < 0$ whenever $\tau_t < \tau_{max}$.

(b) I use the binding censored version of the profit loss term $\Delta(\tau_t, B)$ from equation (27). Log differentiating the cutoff, I obtain

$$\frac{d\ln c_t^U}{d\ln B} = \frac{1}{\sigma - 1}\left(\frac{\beta\gamma}{(1-\beta+\beta\gamma\Delta)}\frac{d\Delta_{t,B}}{d\ln B}\right)$$
$$= -\frac{\sigma}{\sigma-1}\left(\frac{\beta\gamma}{(1-\beta+\beta\gamma\Delta)}\left[\frac{(1-H(B))B^{-\sigma}}{\tau_t^{-\sigma}}\right)\right] < 0.$$

The term is brackets is positive and the cutoff is decreasing in the binding. ■

A.5 Data Sources and Descriptions

I use trade flow and product data for all imported exporter-product pairs from 2004 and 2006. These data are at 10-digit level of disaggregation known as the Harmonized Tariff Items Statistical Codes (HTISC) by Australian Customs. The data were obtained on an annual basis from Trade Data International, an authorized re-seller of trade data from the Australian Bureau of Statistics.[25] In 2004 and 2006, there are 8,179 products that could be exported from any single country to Australia.[26] I account for the 153 code changes during the period from 2002 to 2006 to avoid spurious entry and exit of products.

Tariff data were extracted from the WTO's Tariff Analysis On-line system, a comprehensive database tariff concessions. The Integrated Database includes details at the 8-digit tariff line level for Australia's applied MFN tariffs; Generalized System of Preferences; and other unilateral preference programs. The Consolidated Tariff Schedules contain a record of Australia's certified binding concessions at the HS6 level (the level at which bindings are negotiated).

[25] The HTISC is equivalent to the Harmonized System in the first 6 digits, known as HS6 level. Following the HS6, the next 2 digits capture "tariff items" and are assigned for further disaggregation of tariff duties. The final 2 digits are "statistical codes" assigned to provide additional disaggregation for statistical purposes.

[26] This degree of product diversity is comparable to that found in the 10-digit U.S. import data or Combined Nomenclature of the European Union. For comparison, the level of detail in the HS6 data from the UN COMTRADE database tracks just over 5,000 products due to aggregation.

Table 1: Summary Statistics –Means with standard deviation in parentheses

	2004	2006	Total
Product Traded in 2006 (binary)	0.133	0.117	0.125
	(0.340)	(0.321)	(0.331)
Applied Tariff(ln)	0.045	0.038	0.041
	(0.057)	(0.041)	(0.050)
Binding(ln)	0.100	0.101	0.100
	(0.093)	(0.093)	(0.093)
Binding Uncertainty	0.193	0.210	0.202
	(0.176)	(0.188)	(0.182)
Complex Tariff	0.002	0.002	0.002
	(0.042)	(0.042)	(0.042)
NTB AVE (ln)	0.043	0.043	0.043
	(0.153)	(0.154)	(0.154)
Pos. MFN Tariff	0.570	0.574	0.572
	(0.495)	(0.495)	(0.495)
Observations	302,176	298,794	600,970

Table 2: Probability a product is traded in 2004 and 2006

Dependent Variable: Product Traded (binary)	(1)	(2)	(3)	(4)
Marginal Effects:				
Applied Tariff(ln)	-0.191**	-0.233***	-0.235***	-0.244***
	[0.084]	[0.084]	[0.083]	[0.082]
Binding Uncertainty		-0.030***	-0.030***	-0.029***
		[0.011]	[0.011]	[0.011]
Controls				
Pos. MFN Tariff (binary)	0.037***	0.037***	0.037***	0.037***
	[0.007]	[0.007]	[0.007]	[0.007]
NTB AVE(ln)–2004			-0.008	
			[0.014]	
NTB AVE(ln)–2006			-0.004	
			[0.015]	
Complex Tariff(binary)–2004				0.051
				[0.040]
Complex Tariff(binary)–2006				0.032
				[0.028]
Elasticities of marginal probability a product is traded computed at mean of Binding Uncertainty Measure				
Applied Tariff		-0.139	-0.139	-0.15
		[0.088]	[0.088]	[0.087]
Binding		-0.094	-0.095	-0.094
		[0.035]	[0.035]	[0.035]
Cautionary Effect (p.p.)– attenuation of marginal effect of applied tariff in row 1.		-40.484 [20.228]	-40.655 [20.128]	-38.444 [18.705]
Observations	600970	600970	600970	600970
Adjusted R^2	0.299	0.299	0.299	0.299

Notes:
All columns include exporter×year and industry(HS4)×year fixed effects. Clustered standard errors in brackets (industry×year). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. $\sigma = 4$ for uncertainty measure. Tariff and binding elasticity computed at mean of U^B_{tjv} using equation (16), $e(\tau) = b_\tau - b_B\sigma \times (1 - U^B_{tjv})$, and (17), $e(B) = -b_B\sigma \times (1 - U^B_{tjv})$. See text for derivations.

Table 3: Quantification of the role of policy uncertainty – predicted growth in traded products from policy changes

Predicted new product growth rates and growth shares	2004		2006	
Policy experiments:	Growth Rate	Share	Growth Rate	Share
A. Applied tariff–reduce only applied tariffs to zero	4.9%	44%	4.9%	42%
B. Binding commitments–reduce bindings only to level of current applied tariff	3.3%	30%	4.1%	35%
C. Jointly reduce bindings and applied tariffs to zero (net of A and B)	2.9%	26%	2.7%	23%
Total effect of binding all applied tariffs to zero	11.1%	100.0%	11.6%	100%

Notes:
Estimates computed from coefficient estimates in column 2 of table 2 under the assumption that $\sigma = 4$ for uncertainty measure. Predicted number of products computed as the sum across all observations of the increase in the probability a product is traded by experiment and year. Totals do no add precisely due to rounding error. Growth rates computed relative to true number of traded products in the sample: 40,195 in 2004 and 34,905 in 2006. The smaller total in 2006 is partly due to dropping the U.S. and Thailand from the sample following their PTA implementation. All calcutions are statistically different from zero with standard errors computed via the delta method (unreported). See text for exact formulas.

Table 4: Robustness across alternative elasticity of substitution parameters (σ) for uncertainty measure

Dependent Variable: Product Traded (binary)			
	(1)	(2)	(3)
Elasticity Parameter:	$\sigma = 3$	$\sigma = 4$	$\sigma = 5$
Applied Tariff(ln)	-0.234***	-0.233***	-0.232***
	[0.084]	[0.084]	[0.084]
Binding Uncertainty	-0.037***	-0.030***	-0.025**
	[0.013]	[0.011]	[0.010]
Pos. MFN Tariff(binary)	0.037***	0.037***	0.037***
	[0.007]	[0.007]	[0.007]
Observations	600970	600970	600970
Adjusted R^2	0.299	0.299	0.299

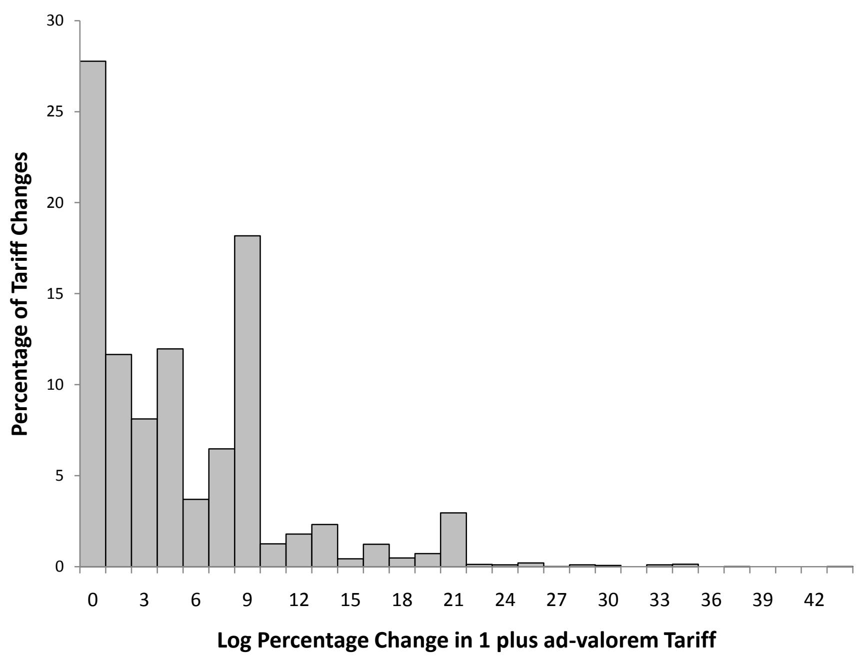
Notes:
All columns include exporter×year and industry(HS4)×year fixed effects. Clustered standard errors in brackets (industry×year). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. $\sigma = 4$ for uncertainty measure. See text for description of elasticity calculations.

Table 5: Robustness to reduced-form estimation on log of bindings and tariffs

Dependent Variable: Product Traded (binary)	(1)	(2)
Applied Tariff(ln)	-0.163*	-0.362***
	[0.086]	[0.138]
Binding(ln)	-0.068**	-0.122***
	[0.027]	[0.035]
Tariff×Binding(ln)		0.852***
		[0.321]
Pos. MFN Tariff (binary)	0.037***	0.043***
	[0.007]	[0.008]
Observations	600970	600970
Adjusted R^2	0.299	0.299

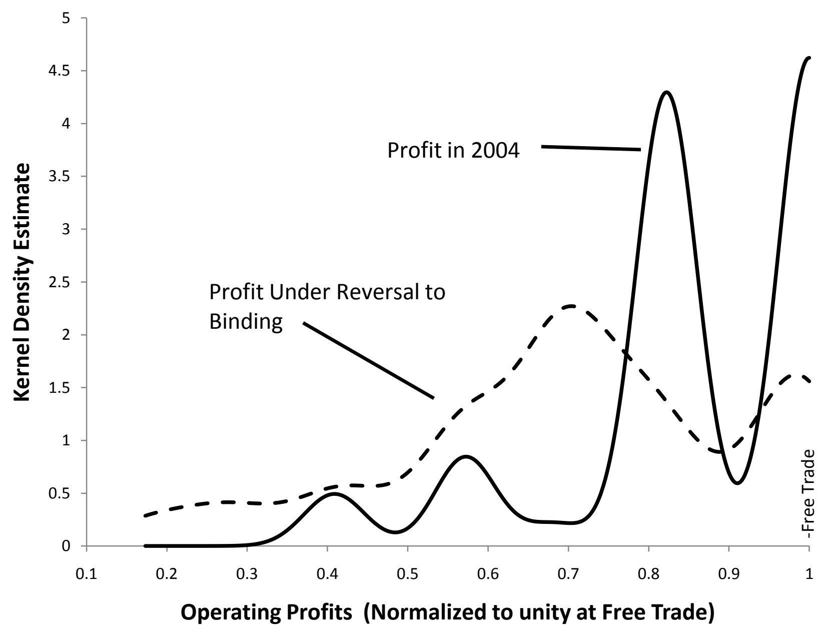
Notes:
All columns include exporter×year and industry(HS4)×year fixed effects. Clustered standard errors in brackets (industry×year). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. $\sigma = 4$ for uncertainty measure. See text for description of elasticity calculations.

Figure 1: Distribution of tariff changes under a binding reversal in 2004



Notes: Change in log points from the MFN tariff to the bound tariff in 2004. $100 \times \ln(B_v/\tau_v)$ where $B, \tau = (1 + \text{ad-valorem rate})$. Bin width is 1.5 log points.

Figure 2: Shift in distribution of profits under a binding reversal in 2004 at applied (MFN rate) vs bound tariff levels



Notes: Kernel densities. Profits are normalized to unity at $\tau = 1$. Higher tariffs scale down profits by $\tau^{-\sigma}$ in the model. I compute the operating profit for all product lines at the applied MFN tariff in 2004. I then compute profits in 2004 as if there had been reversal to the worst case bound tariffs.