Firm Input Choice Under Trade Policy Uncertainty

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Abstract

We examine the role of trade policy uncertainty in shaping the import decisions of firms. If the adoption of a new input – domestic or imported – requires a sunk cost investment, then firms respond to the time path of input prices, including any uncertainty arising from potential trade policy changes. Reductions in an input's price uncertainty increase adoption. We derive the implications of this mechanism and estimate the impacts of an important episode that lowered input price uncertainty: China's accession to the WTO and the associated commitment to bind its import tariffs. We find large increases in the range and value of imported inputs at the firm level caused by reductions in input price uncertainty beyond those implied by the reductions in applied tariffs in 2000-2006.

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1 Introduction

We examine the role of policy uncertainty in shaping the input decisions of firms. If new inputs require a sunk cost investment, then firm adoption decisions must account for any uncertainty about the time path of input prices. Any uncertainty about future policy that affects input prices, e.g. taxes on domestic or imported inputs, will then affect the level and mix of inputs the firm adopts. We develop a theoretical model of this phenomenon and test its key implications using detailed firm data on input usage and shocks to current and expected import taxes arising from China's WTO accession.

We contribute to the research on three important issues. First, there is extensive research on global sourcing and the determinants of increased intermediate trade but it has ignored the role of policy uncertainty. Intermediate inputs account for the bulk of world trade (Johnson and Noguera, 2012), and vertical specialization across countries is a prominent feature of the world economy (Hummels et al., 2001). Trade liberalization, in particular, has been shown to be a major contributor to the growth in vertical specialization (Hanson et al., 2005; Johnson and Noguera, 2017) with important implications for, inter alia, productivity and welfare (Amiti, and Konings, 2007; Goldberg et al., 2010; Halpern et al., 2015).

Virtually all work on input trade treats policy as parametric, whereas recent research on exporting shows that trade policy uncertainty reductions increase trade (Feng, Li and Swenson, 2017; Handley, 2014, Handley and Limão, 2015; Pierce and Schott, 2016). In these papers, because of sunk costs, the response of export decisions to a foreign tariff reduction depends on firms' beliefs about whether the policy change is permanent or reversible, and trade agreements play a role in shaping such beliefs. Handley and Limão (2017) show this has important price and welfare effects and extend this logic to entry and technology-upgrading decisions but not to global sourcing decisions. As Antràs, et al. (2017) note, sourcing is a more complex problem than exporting in that it involves a portfolio of inputs with potential interactions between them. Our contribution here is to examine how trade policy uncertainty (TPU) affects global sourcing decisions.

We also contribute to the analysis of the role of international trade agreements. Existing theories emphasize the role of agreements in addressing terms-of-trade externalities (Bagwell and Staiger, 1999; Grossman and Helpman, 1995), or allowing governments to commit vis-a-vis domestic actors (e.g. Maggi and Rodriguez-Clare, 1998) or reducing TPU (Limão and Maggi, 2015). There is increasing evidence for the terms-of-trade role of agreements (Broda, Limão, Weinstein, 2008, Bagwell and Staiger, 2011) but less so on own commitment effects (as noted by Maggi, 2014). The papers studying the effect of TPU on exports provide support for the idea that a country's exporters benefit from tying the hands of the foreign government. We provide evidence that suggests agreements may provide a valuable commitment device to the importing country: by tying its own hands it spurs investment in adoption of imported inputs.

Finally, our empirical application contributes to the large literature examining the impressive growth in Chinese firm exports, imports and productivity after its 2001 WTO entry. This work includes the effects of reductions in Chinese applied tariffs (Amiti, et. al. 2018; Brandt, et. al., 2017; Feng, Li and Swenson, 2016; Yu, 2015) and reductions in U.S. TPU that Chinese exporters faced in the U.S. (Feng, Li and Swenson, 2017; Handley and Limão, 2017; Pierce and Schott, 2016). Both of these channels are potentially important for Chinese export outcomes.[1] Our contribution here is to go beyond the applied reductions in Chinese tariffs and also estimate and quantify the impact of its commitments not to reverse its liberalization on intermediate usage and adoption.

In our model firms invest to adopt a range of intermediates used to produce a differentiated product under uncertainty in input prices driven by policy, e.g. taxes. Similarly to recent firm-based frameworks greater input variety reduces the firm's marginal cost but each variety requires a cost to adopt (c.f. Halpern et al., 2015; Antràs, et al., 2017; Blaum et al., 2018). Unlike such frameworks, we model adoption costs as sunk, which implies the firm sourcing decision is a dynamic one and introduces a role for policy uncertainty. We focus

[1] Amiti, et. al. (2017) find that both lower Chinese input tariffs and US TPU contributed to the reduction in their export prices to the US.

on shocks to relative prices between imported and domestic inputs arising from TPU, e.g. a reduction in the probability of tariff increases. The direct effect of a reduction in the current tariff or in TPU of a category i is to increase adoption of imported inputs in i (as well as the number of varieties and values associated with it): a substitution effect. Moreover, this reduction in protection or TPU also increases adoption and usage of inputs in other input categories j: due to a profit effect and input complementarity in our setting.

We use transactions-level trade data from 2000-2006 to examine how Chinese WTO tariff commitments affected its imports, we focus on intermediate imports at the firm level but also provide evidence at other levels of aggregation. After its economic reform and opening in late 1970s, China started an effort to re-enter the GATT in the mid-1980s and then its successor, the WTO, which it accessed in 2001. China underwent considerable tariff reforms throughout the 1990s, some of it as a pre condition to enter the WTO (cf. Tang and Wei, 2009), which included lowering average tariffs from over 40% in the early 1990's to below 20% at the end of the decade; it further reduced tariffs to below 10% in the early 2000s (see Figure 1). China's accession process was long (1986-2001) and the outcome was uncertain until it joined in December of 2001. Several events over this period threatened to derail the accession process and China's prior trade liberalization could have been reversed.[2] This potential reversal hung over Chinese importers, just as the U.S. annual threat of removal of China's MFN status hung over its exporters.

If WTO accession increased the cost of reversing China's tariff reforms then our model predicts it should have increased imported input adoption. To test this we construct a measure of tariff risk for imported inputs in each HS-6 category consistent with the model: the difference between the historical mean tariff dating back to 1992 and its respective current rate. In the raw data import value (and variety) growth between 2006-2000 was about 20 lp higher for products with higher risk, consistent with a reduction in the probability of

[2] These included the death and succession of Deng Xiaoping, the Tiananmen Square protests, and diplomatic crises over the Taiwan Strait, U.S. bombing of the Chinese embassy in Serbia, the midair collision of a U.S. spyplane witha Chinese fighter jet.

reversal. The regression analysis, which controls for applied tariff changes and various fixed effects, shows that this tariff risk depressed Chinese firms' imported inputs prior to WTO entry, and that this effect is sharply reduced after WTO entry, consistent with increased commitment. We find evidence for the mechanism of the model. First, the effects are present not only for values but also the number of varieties. Second, the applied tariff trade elasticity increases substantially after WTO entry, suggesting that importers perceived them to be more permanent. At least half of the predicted growth in intermediate imports attributable to WTO accession in our estimates are from locking in *previous* tariff reductions.

We provide the theoretical model in section 2, the data and empirical strategy in section 3; the estimates and preliminary quantification in 3.3 and conclude in section 4. Derivation and estimation details are in the appendices.

2 Model

We consider a dynamic model of heterogeneous firms producing a differentiated final product from a primary factor (labor) and a multitude of intermediate inputs. Firms take input prices as given and set output prices as a constant markup over marginal cost. Firms enter and exit the market at a constant rate, such that the mass of firm is fixed in each period. Specifically, any firm present in the market in period t remains in the market in period $t+1$ with probability β—the firm's exogenous survival probability.[3] Upon entering, the firm is endowed with a constant productivity parameter φ drawn from an i.i.d. distribution $F(\varphi)$.

There are three key assumptions regarding inputs. First, there are $i = \{1, ...N\}$ types of inputs each characterized by a CES aggregator over a continuum of varieties. Second, the varieties in each i are divided into two sets—Ω_i and Ω_i^*—and those in the former have constant prices while the price of a typical variety in Ω_i^* changes over time according to a Markov process. Specifically, we denote τ_i^t as the price of a typical variety in Ω_i^* in period t relative to that of one in Ω_i, where the later is normalized to unity. In the initial period the

[3] Firms do not discount the future, though including a discount factor would not affect the results.

relative price is τ_i^l, and there is a constant probability γ of an increase to τ_i^h in the following period, so we refer to these as the *exposed inputs*. Third, the firm must pay a one-time sunk cost for each variety it adopts K_v.

In principle, our model could be applied to any context with irreversible investments where some inputs are more exposed to downside price risk. For example, it could be applied to the "make or buy" decision of a firm by letting Ω_i be the set of internally-produced varieties, Ω_i^* be the set of varieties purchased arms-length, τ_i^t be the market price relative to the internal cost, and γ be the probability of an adverse price shock. In a policy context, we can think of γ as the probability of a policy change, where varieties in Ω^* are directly subject to the policy. In our empirical application, Ω_i is taken to be the set of domestic varieties, Ω_i^* is the set of imported varieties, τ_i^t is the tariff-inclusive relative price of imported varieties, and γ is the probability that the government reverts to a more protectionist regime.

Two important details about the Markov process governing relative prices are the degree of persistence of the shocks and the covariance of shocks across inputs. At one extreme is the case in which shocks are temporary and independent across inputs. At another, shocks are permanent (i.e., τ^h is an absorbing state) and perfectly correlated across inputs (albeit τ_i^h may vary across inputs). In what follows, we focus on this second case, in keeping with our empirical application.

2.1 Preferences, Technology and Current Profits

Each firm faces a constant elasticity demand for its output given by,

$$q = Ep^{-\sigma} \tag{1}$$

where p is the endogenous consumer price, $E > 0$ is an exogenous demand shifter and $\sigma > 1$ the constant demand elasticity. This demand could be derived from a CES utility function, in which case E would contain the price index. Holding E constant, therefore, is equivalent to assuming that the final goods market is large relative to the mass of firms under consideration.

Production is Cobb-Douglas in labor and N intermediate inputs, with a firm-specific productivity parameter φ:

$$y = \varphi l^{1-\alpha} \Pi_{i=1}^{N} x_i^{\alpha_i} \tag{2}$$

where l is labor input and x_i is the quantity of input i, and $\Sigma_{i=1}^{N} \alpha_i = \alpha < 1$. Each input is available in a continuum of different varieties ν aggregated with constant elasticity of substitution $\theta > 1$:

$$x_i = \left[\int_{\nu \in \Omega_i \cup \Omega_i^*} x_i(\nu)^{\frac{\theta-1}{\theta}} d\nu \right]^{\frac{\theta}{\theta-1}} \tag{3}$$

Given a current relative price of τ_i for exposed varieties, $\nu \in \Omega_i^*$, the current cost index for input i is $z_i^{\frac{1}{1-\theta}}$, where

$$z_i = z_i \left(n_i, n_i; \tau_i \right) = n_i + n_i^* \tau_i^{1-\theta}, \tag{4}$$

and n_i and n_i^* are the equilibrium measures of varieties. The cost index for each i is decreasing in the number of varieties of either type.

Aggregating over all inputs, the unit cost of the final good is,

$$c = \varphi^{-1} \tilde{\alpha} \Pi_{i=1}^{N} z_i^{\frac{\alpha_i}{1-\theta}} \tag{5}$$

where $\tilde{\alpha} \equiv \Pi_{i=1}^{N} \alpha_i^{-\alpha_i} \left(1-\alpha\right)^{\alpha-1}$.

The profit-maximizing price of the final good is $\hat{p} = \frac{\sigma}{(\sigma-1)} c$ and implies operating profits given by

$$\pi(z) = A \varphi^{\sigma-1} \Pi_{i=1}^{N} z_i^{\frac{\alpha_i(\sigma-1)}{\theta-1}} \tag{6}$$

where $A \equiv E \sigma^{-\sigma} (\sigma-1)^{\sigma-1} \left(\tilde{\alpha}\right)^{1-\sigma}$, and $z = \{z_1, z_2 ..., z_N\}$.

The partial derivative of the profit function with respect to z_i is

$$\pi_{z_i}(z) = \pi(z) \left(\frac{\sigma-1}{\theta-1} \right) \frac{\alpha_i}{z_i} > 0 \tag{7}$$

We show in the appendix that $\pi(z)$ is strictly concave if $\alpha\left(\frac{\sigma-1}{\theta-1}\right) < 1$. This is satisfied if $\theta > \sigma$, i.e. if the elasticity of substitution between two varieties within an i exceeds the consumption elasticity between final goods, which we assume henceforth. Furthermore, differentiation of (7) yields $\pi_{z_i z_j}(z) > 0$ for all $i \neq j$, and thus $\pi(z)$ is supermodular.

2.2 Input Choice under Certainty

We first solve the benchmark problem with certainty, i.e. when either $\gamma = 0$ or $\tau_i^l = \tau_i^h = \tau_i$ for all i. We partition the set of varieties with constant price into two $\Omega_i = \Omega_i^0 \cup \Omega_i^{\tilde{}0}$, where Ω_i^0 has measure $n_i^0 > 0$ for all i and denotes the subset of varieties with $K_v = 0$. Given CES, all firms optimally choose to at least adopt n_i^0.[4] The firm must then decide decide whether to expand inputs from either $\Omega_i^{\tilde{}0}$ or Ω_i^* at a sunk cost of either K or K^* respectively. The firm's problem is to maximize the expected present value of profits net of adoption costs,

$$V(z) = \frac{\pi(z)}{1-\beta} - \sum_{i=1}^{N} \left[K\left(n_i - n_i^0\right)\mathbf{1}_{n_i > n_i^0} + K^* n_i^*\right] \tag{8}$$

where $\mathbf{1}_{n_i > n_i^0}$ is an indicator function equal to 1 if $n_i > n_i^0$ and zero otherwise, and n_i^* is constrained to be non-negative.

The first-order condition compares the marginal operating profit from expanding the extensive margin with marginal cost of adding type of input variety, whichever cost is lower, yielding:

$$\frac{\pi_{z_i}(z)}{1-\beta} \leq \min\left\{K, K^* \tau_i^{\theta-1}\right\} \tag{9}$$

If the above inequality is strict, then the firm chooses not to expand the extensive margin of input i at all and instead remains at $n_i = n_i^0$ and $n_i^* = 0$. As the firm's marginal operating profit is proportional to its productivity, firms with low productivity may fall into this category for some (possibly all) inputs. In what follows, we focus on firms productive

[4] This can also be thought of as the baseline technology the firm is endowed with. If n_i^0 is not positive for all i then only sufficiently productive firms incur the sunk cost to adopt all necessary i and we would have a production productivity threshold.

enough that (9) holds with equality for all i under certainty even at τ_i^h.

Expansion of the extensive margin of a given input will occur along only one of the two dimensions. Safe varieties will be added ($n_i > 0$ and $n_i^* = 0$) if and only if,

$$\rho_i \equiv \frac{K^*}{K}\tau_i^{\theta-1} > 1 \tag{10}$$

whereas exposed varieties ($n_i = n_i^a$ and $n_i^* > 0$) will be added if $\rho_i \leq 1$. The choice of dimension on which to expand depends only on the relative cost of the exposed varieties, ρ_i, and not on firm characteristics or input shares. Thus the set of inputs for which the firm prefers exposed varieties $M = \{i|\rho_i \leq 1\}$ is not firm specific for the subset of sufficiently productive firms we are currently considering.

Solving (9) for $i \notin M$ yields the optimal measure of safe varieties,

$$n_i = \pi\alpha_i B \tag{11}$$

where $B \equiv \frac{\sigma-1}{(\theta-1)(1-\beta)K}$. For $i \in M$, the optimal measure of exposed varieties is:

$$n_i^* = \pi\alpha_i B^* - n_i^0\tau_i^{\theta-1} \tag{12}$$

Equations (11) and (12) imply that $z_i = \pi\alpha_i B$ for $i \notin M$ and $z_i = \pi\alpha_i B^*\tau_i^{1-\theta}$ for $i \in M$. Substituting these values into (6) and solving gives the optimal operating profit,

$$\pi = \bar{\pi}(\varphi)\Pi_{i\in M}\left[\rho_i^{\frac{-\alpha_i}{\alpha}(\Theta-1)}\right] \tag{13}$$

where $\Theta \equiv \left[1 - \frac{\alpha(\sigma-1)}{\theta-1}\right]^{-1} > 1$ and

$$\bar{\pi}(\varphi) \equiv \left(A\varphi^{\sigma-1}\right)^{\Theta}\left[\Pi_{i=1}^{N}\left(\alpha_i B\right)^{\frac{\alpha_i}{\alpha}}\right]^{\Theta-1}$$

Note that $\bar{\pi}(\varphi)$ contrained-optimal operating profit if no varieties from Ω^* were available or were infinitely costly. Substituting (13) into (12) yields a closed-form solution for the optimal measure of exposed varieties

$$n_i^* = n_i^0 \tfrac{K}{K^*} \left[\eta_i \left(\varphi \right) \Pi_{j \in M} \left(\rho_j^{\frac{-\alpha_j}{\alpha}(\Theta - 1)} \right) - \rho_i \right] \tag{14}$$

where $\eta_i(\varphi) \equiv \bar{\pi}(\varphi)\alpha_i B / n_i^0$. The term $\eta_i(\varphi)$ captures the combined effects of firm productivity and input shares. As equation (14) shows, the optimal measure of exposed varieties of i decreases with the relative cost of such varieties in i as well as in all other inputs due to supermodularity.

We can also solve for the firm's optimal expenditure on exposed varieties of an input. The firm's total expenditure on input i is given by $\alpha_i \left(\sigma - 1 \right) \pi$, which follows from the Cobb-Douglas input technology (see appendix). Given CES at the variety level, firm spending on each exposed variety of input i is $\frac{\tau_i^{1-\theta}}{z_i} \alpha_i \left(\sigma - 1 \right) \pi$. Using (7) and (9) in this expression and multiplying by n_i^*, we arrive at firm spending on all exposed varieties of i:

$$m_i^* = n_i^* \frac{\sigma - 1}{B^*} \tag{15}$$

The general expression for the expenditure share on exposed inputs is

$$s_i^* = \frac{n_i^* \tau_i^{1-\theta}}{n_i + n_i^* \tau_i^{1-\theta}}. \tag{16}$$

Using (11), (13) and (14) gives,

$$s_i^* = 1 - \frac{\rho_i}{\eta_i \left(\varphi \right)} \Pi_{j \in M} \left(\rho_j^{\frac{\alpha_i}{\alpha}(\Theta - 1)} \right) \tag{17}$$

Normalizing the mass of firms to one and aggregating, the exposed spending across all firms is:

$$M_i^t = n_i^0 \left(\tfrac{K}{K^*} \right) \left[\left(\int \eta_i \left(\varphi \right) dF \right) \Pi_{j \in M} \left(\rho_j^{\frac{-\alpha_j}{\alpha}(\Theta - 1)} \right) - \rho_i \right] \frac{\sigma - 1}{B^*} \tag{18}$$

Thus aggregate exposed spending has the same form as it does at the firm level.

2.3 Input Choice under Uncertainty

We introduce uncertainty by modelling the vector of relative prices of exposed inputs, τ, that starts at τ^l initially and has a constant probability of increasing to $\tau^h \geq \tau^l$ and henceforth remains there. The increases can differ across i. The present discounted value of a firm's operating profit in the initial state is now defined recursively by,

$$\tilde{V}\left[z\left(n,n^*;\tau\right)\right]=\pi\left[z\left(n,n^*;\tau^l\right)\right]+\beta\left(1-\gamma\right)\tilde{V}\left[z\left(n,n^*;\tau\right)\right]+\beta\gamma\frac{\pi\left[z\left(n,n^*;\tau^h\right)\right]}{1-\beta} \tag{19}$$

Implicit in this equation is an assumption that, having adopted (n, n^*) under τ^l, the firm chooses not to change the input mix after transitioning to τ^h. Note that it is never optimal for the firm to decrease (n, n^*) after the *sunk* adoption cost is incurred. It is also not optimal to increase n^* because the relative prices increased and π is supermodular. However, it remains to be shown that it would not be optimal for the firm to expand some inputs as their relative price falls. An additional assumption is required to ensure that this substitution effect of n_i for a given n_i^* does not outweight the profit effect on the demand of n_i (as usage of exposed inputs falls).[5]

To simplify notation, let $z^i = z\left(n, n^*; \tau^i\right)$ for $i = l, h$. After solving (19), total profits can be written as,

$$V(z^l,z^h)=\frac{\pi(z^l)}{1-\beta}\cdot\underbrace{\frac{1+u\left[\pi(z^h)/\pi(z^l)\right]}{1+u}}_{\equiv U(u,z)}-\sum_{i=1}^{I}\left[K\left(n_i-n_i^0\right)\mathbf{1}_{n_i>n_i^0}+K^*n_i^*\right] \tag{20}$$

which the firm wishes to maximize subject to $n_i, n_i^* \geq 0$. The first term on the right-hand side of (20) is the present-discounted value of operating profits if prices remained at the current level. This value is reduced by the uncertainty factor $U\left(\gamma, z\right) \in (0, 1]$, strictly so whenever prices can change, $u \equiv \frac{\beta\gamma}{1-\beta} > 0$, leading to worse conditions $\pi(z^h) < \pi(z^l)$.[6]

[5] In appendix B.3 we show that a sufficient condition is that $\rho_i^l < \rho_i^h < 1$ or $1 < \rho_i^l < \rho_i^h$, for all i, which is satisfied as$\rho_i^l \to \rho_i^h$: the point around which we approximate our model for the empirical estimation.

[6] This term is similar to what Handley and Limao (2015) identify in the context of uncertainty faced by

The optimal extensive margins for input i satisfy the first-order condition:

$$\frac{\pi_{z_i}(z^l)+u\pi_{z_i}(z^h)}{(1+u)(1-\beta)}=\min\left\{K,K^*\left(\tau_i^l\right)^{\theta-1}+\frac{u\pi_{z_i}(z^h)}{(1+u)(1-\beta)}\left[1-\left(\frac{\tau_i^h}{\tau_i^l}\right)^{1-\theta}\right]\right\} \tag{21}$$

We see two effects of uncertainty on input decisions. First, uncertainty affects the expected value of operating profits and thus the expected marginal benefit of adding to the extensive margin. This is captured on the left-hand side of (21). Second, the right-hand side shows that uncertainty affects the decision about which margin to expand. The marginal cost of adding a safe variety is the same as under certainty. The marginal cost of adding an exposed variety is higher than under certainty by an amount $\frac{u}{1+u}\frac{\pi_{z_i}(z^h)}{(1-\beta)}\left[1-\left(\tau_i^h/\tau_i^l\right)^{1-\theta}\right]$, which captures the direct exposure of an exposed variety to the potential of a permanently higher price.

If the right-hand side of (21) equals K, then the firm chooses $n_i^*=0$ and the optimal measure of safe varieties is

$$n_i^u=\alpha_i B\frac{\pi(z^l)+u\pi(z^h)}{(1+u)} \tag{22}$$

As under certainty, the safe input margin is proportional to expected operating profits.

Using (22) in (21), the condition for a firm to weakly prefer the exclusive use of safe varieties to exposing a single variety to uncertainty becomes,

$$\rho_i^l\geq 1-\frac{u\pi(z^h)}{\pi(z^l)+u\pi(z^h)}\left[1-\left(\frac{\tau_i^h}{\tau_i^l}\right)^{1-\theta}\right] \tag{23}$$

According to (23) the decision to begin exposing input i depends on current price via ρ_i^l, the high-price penalty τ_i^h/τ_i^l, and aggregate uncertainty. So if under certainty at τ_i^l a firm is indifferent between inputs, $\rho_i^l=1$, then that same firm strictly prefers the safe input under uncertainty since the RHS is lower than unity.

If condition (23) fails, then $n_i^u=n_i^0$ and n_i^{*u} satisfies,

a final good exporter where the ratio of operating profits under alternative tariffs on a final good j reduces to $\left(\tau_j^h/\tau_j^l\right)^{-\sigma}$ whereas here it depends on the set of all *input* tariffs.

$$\frac{1}{1+u}\frac{\pi(z^l)\alpha_i B^*}{\left(n_i^{*u}+n_i^0\left(\tau_i^l\right)^{\theta-1}\right)}+\frac{u}{1+u}\frac{\pi(z^h)\alpha_i B^*}{\left(n_i^{*u}+n_i^0\left(\tau_i^h\right)^{\theta-1}\right)}=1$$

which is quadratic in n_i^{*u}. In the appendix we solve this and obtain

$$n_i^{*u}=n_i^0\tfrac{K}{K^*}\left[\eta_i(\varphi)\frac{\pi(z^l)}{\bar{\pi}}\cdot U\left(u,z\right)\left(1-\psi_i\right)-\left(1-\psi_i\right)\rho_i^l-\psi_i\rho_i^h\right] \tag{24}$$

where $\psi_i\in[0,1]$ is an input-specific uncertainty factor.[7] As uncertainty goes to zero, so $\psi_i\to 0$, $U\to 1$ so $n_i^{*u}\to n_i^*$, which is the exposed extensive margin under certainty in (12).

The firm's optimal expenditure on exposed varieties of an input is,

$$m_i^u=s_i^{*u}\alpha_i\left(\sigma-1\right)\pi^l \tag{25}$$

where $s_i^{*u}=\frac{n_i^{*u}\left(\tau_i^l\right)^{1-\theta}}{n_i^0+n_i^{*u}\left(\tau_i^l\right)^{1-\theta}}$.

2.4 Approximation

For the purposes of estimation it is useful to work with a first-order Taylor expansion of the log of (24) around the points $\rho_{i0}^l=\rho_{i0}^h=\rho_0$ and $\eta_i\left(\varphi\right)=\eta_0$ for all $i\in M$. Specifically,

$$\begin{aligned}\ln n_i^{*u}\approx\ln n_{i0}^*+\frac{1}{s_0^*}\ln\left(\frac{\eta_i\left(\varphi\right)}{\eta_0}\right)-\frac{1-s_0^*}{s_0^*}\left[\ln\left(\frac{\rho_i^l}{\rho_0}\right)+\ln\left(\frac{\rho_i^h}{\rho_i^l}\right)\frac{u}{1+u}\right]\\-\frac{\Theta-1}{s_0^*}\sum_{j\in M}\frac{\alpha_j}{\alpha}\left[\ln\left(\frac{\rho_j^l}{\rho_0}\right)+\ln\left(\frac{\rho_j^h}{\rho_j^l}\right)\frac{u}{1+u}\right]\end{aligned} \tag{26}$$

which is derived the appendix.[8] The bracketed term in the top line of (26) captures the combined effects the current tariff and tariff uncertainty on input i. Both terms enter

[7] Specifically, it is $\psi_i=\frac{1}{2}-\frac{1}{2}\left\{1-4\frac{u}{1+u}\eta_i(\varphi)\frac{\pi(z^h)}{\bar{\pi}}\left(\rho_i^h-\rho_i^l\right)\left(\eta_i(\varphi)\frac{\pi(z^l)}{\bar{\pi}}U\left(u,z\right)+\rho_i^h-\rho_i^l\right)^{-2}\right\}^{1/2}$

[8] Recall that $\eta_i(\varphi)\equiv\bar{\pi}(\varphi)\alpha_i B/n_i^0$ so a common η_0 implicitly requires approximating around a common productivity for firms and a common α_i/n_i^0. For simplicity we assume the latter is constant, i.e. the measure of inputs in i with $K_v=0$ is proportional to their exogenous expenditure share α_i. Alternatively, we can re-derive the approximation explicitly around common α_i and n_i^0.

negatively. The bracketed term on the second line captures effects on input i of tariffs and uncertainty in the aggregate. These too are negative, because both higher current tariffs and higher uncertainty lower profits, which lowers demand for each input i.

We can similarly approximate the equation for firm's optimal expenditure on exposed varieties of an input i,

$$\ln m_i^u \approx \ln m_{i0}^u + \frac{(1-s_0^*)}{s_0^*} \ln\left(\frac{\eta_i(\varphi)}{\eta_0}\right) - \frac{1-s_0^*}{s_0^*}\left[\ln\left(\frac{\rho_i^l}{\rho_0}\right) + (1-s_0^*)\ln\left(\frac{\rho_i^h}{\rho_i^l}\right)\frac{u}{1+u}\right]$$
$$- \frac{\Theta-1}{s_0^*}\sum_{j\in M}\frac{\alpha_j}{\alpha}\left[\ln\left(\frac{\rho_j^l}{\rho_0}\right) + \left(1-\frac{s_0^{*2}}{\Theta}\right)\ln\left(\frac{\rho_j^h}{\rho_j^l}\right)\frac{u}{1+u}\right] \tag{27}$$

The form of the expenditure equation (27) is similar to the extensive margin in equation (26) except that the coefficient on the uncertainty term $\ln\left(\frac{\rho_i^h}{\rho_i^l}\right)\frac{u}{1+u}$ is smaller in the expenditure equation. This is because uncertainty directly effects the extensive margin, due to the sunk cost. The extensive margin will always be lower than ideal in the low price state and higher than ideal in the high price state. Given the extensive margin, however, the firm can always adjust its intensive margin (expenditure per variety) based on the current prevailing price, raising it if the price is low and lowering it if the price is high. This partially compensates for the distorted extensive margin, and has the effect if mitigating the depression of the overall expenditure on exposed varieties in response to uncertainty.

3 Estimation

We describe the econometric specifications implied by the model for firm-specific imported input value and number of varieties of i. We then describe the data and provide non-parametric evidence, followed by the baseline regression results, robustness and quantification.

3.1 Specifications

We use variation in applied tariffs, our uncertainty measure and the timing of WTO accession to estimate substitution effects predicted by the model. Our rich firm-level data allows us to control for profit effects of higher input use by using firm or firm-time fixed effects. Below, we describe the steps and identification assumptions necessary to obtain our baseline estimation equations.

There are several determinants for the relative price of an imported input to a domestic one, denoted by τ_{it} in the theory. Moreover, there are multiple heterogeneous inputs even within i so we are unable to precisely measure this relative price. Thus we rely on a parsimonious empirical model of τ_{it} where the key determinant is the average applied import tariff in category i, denoted by $\bar{\tau}_{it}$. We control for other factors as follows

$$\ln \tau_{it} = \ln \bar{\tau}_{it} + \delta_{t,c} + e^{\delta}_{it,c},$$

where the time effect, δ_t, controls for aggregate shocks, e.g. to real exchange rates, and in certain specifications allows these to be exporter c specific, δ_{tc}, e^{δ}_{it} is i.i.d. random noise. Thus the overall relative price including the sunk costs is[9]

$$\ln \rho^{l}_{it} = (\theta - 1) \ln \bar{\tau}_{it} + (\theta - 1) \left[\delta_{t,c} + e^{\delta}_{it,c} \right] + \ln(K^{*}_{t}/K_{t}). \tag{28}$$

The time series of previous tariffs is observable to the researcher and firms. We measure the potential threat tariff in the high state by setting $\ln \tau^{h}_{i}$ equal to the historical, pre-accession average tariff by product. Importer beliefs may differ from this threat tariff, so we also model the weight $h \in [0, 1]$ placed on the observable threat relative to the weight $1 - h$

[9] We also test robustness to including more time-varying sector effects δ_{It} to allow for other unobserved heterogeneity in relative prices. We can also allow for unobserved variation in relative sunk costs across firms since the baseline will include firm-time effects.

on another unobservable, constant tariff $\ln \tau$ to obtain

$$\ln \tau_{it}^{h} = h \ln \tau_{i}^{h} + (1-h) \ln \tau + e_{it}^{h}. \tag{29}$$

We assume that the idiosyncratic term is orthogonal to τ_i^h and τ_{it}^l and that $e_{it}^h \sim N(0, \sigma)$.

Using (29), (28) in equations (26) and (27) from the model, we can derive econometric specifications for several trade outcomes. The general version for an outcome y is

$$y_{it} = \beta_{\tau t}^{y} \ln \bar{\tau}_{it} + \beta_{ht}^{y} \ln \frac{\tau_i^h}{\bar{\tau}_{it}} + \mathbf{a}_{I,f,t} + e_{ift}.$$

The set of possible dependent variables y includes varieties ($\ln n$) and import values ($\ln m$). We include a set of fixed effects $\mathbf{a}_{I,f,t}$ for industry, firm, time, and some of their interactions. The current ad valorem tariff factor $\bar{\tau}_{it}$ and the threat tariff τ_i^h are observed. The composite error term e_{ift} includes idiosyncratic firm-product-time shocks, the approximation error, and the error terms from the empirical model of relative price and beliefs.

The coefficients on applied tariffs and the risk factor $\beta_{\tau t}^y$ and β_{ht}^y are time-varying in general through γ_t. If input TPU is present, i.e. $\gamma_t > 0$, and importers place weight on our measure of the threat tariff $h > 0$, then the theory predicts that $\beta_{ht}^y < 0$. To estimate the coefficients, we employ variation in risk across products i and time t to estimate substitution effects between domestic and foreign varieties within firms, while controlling for firm profit effects on its bundle of all inputs.

We model accession using an indicator variable for the post-period, i.e. $\mathbf{1}_{wto}(t > 2001)$, to test whether there is an uncertainty shock $\Delta\gamma = \gamma_{wto} - \gamma_{pre}$. This approach yields the baseline specification

$$y_{it} = \left(\beta_{\tau,pre}^{y} + \Delta\beta_{\tau}^{y} \times \mathbf{1}_{wto}\right) \ln \bar{\tau}_{it} + \left(\beta_{h,pre}^{y} + \Delta\beta_{h}^{y} \times \mathbf{1}_{wto}\right) \ln \frac{\tau_i^h}{\bar{\tau}_{it}} + \mathbf{a}_{I,f,t} + e_{ift}.$$

For all outcomes, $\beta_{h,pre} < 0$ when $\gamma_{pre} > 0$ and $h > 0$, as above. Applied tariffs have a negative effect on import outcomes, $\beta_{\tau,pre} < 0$, in the pre-WTO period. The theory then predicts there is a reduction in uncertainty if $\Delta\beta_h^y = \beta_{h,wto}^y - \beta_{h,pre}^y > 0$ when $h > 0$. The theory also predicts an increases the responsiveness to applied tariffs estimated by $\Delta\beta_\tau^y = \beta_{\tau,wto}^y - \beta_{\tau,pre}^y < 0$ for beliefs with $h < 1$. The latter condition on h reflects firm placing weight on some weight on threats other than the historical mean τ_i^h.

The coefficients have a deeper structural interpretation relative to the model and our approximation point. The coefficients and their predicted sign for variety adoption are:

$$\beta_{ht}^{n^*} \equiv -\frac{1-s_0}{s_0}(\theta-1)\frac{u_t}{1+u_t}h \leq 0 \tag{30a}$$

$$\beta_{\tau,t}^{n^*} \equiv -\frac{1-s_0}{s_0}(\theta-1)\left[1-\frac{u_t}{1+u_t}(1-h)\right] < 0 \tag{30b}$$

The import coefficients on the tariff threat are a re-scaled version of the variety coefficients: $\beta_{ht}^m = (1-s_0)\beta_{ht}^{n^*}$. The coefficient on the applied tariff is $\beta_{\tau,t}^m = -\frac{(1-s_0)}{s_0}(\theta-1)\left[1-\frac{u_t}{1+u_t}(1-h)(1-s_0)\right]$. The applied tariff elasticity in the absence of uncertainty is $-\frac{1-s_0}{s_0}(\theta-1)$ so we can see how it is attenuated by uncertainty because this term is multiplied by a term in [] that is less than unity when $u > 0$ (and $h < 1$).

We use the structural interpretation of the coefficients to isolate the belief parameter h using the expression

$$h = \frac{\Delta\beta_h^y}{\Delta\beta_h^y - \Delta\beta_\tau^y}.$$

This relationship holds for both varieties and import values and we provide an estimate of h in the results below.

3.2 Data and Non-parametric Evidence

We combine rich Chinese transaction-level trade data from 2000-2006 with detailed product specific tariffs and risk measures from before and after WTO accession. First, we describe some details of the firm and tariff data. Second, we provide some non-parametric evidence that is consistent with the main predictions of our model.

3.2.1 Data

The trade data we use are Chinese transaction-level trade data in the period from 2000-2006. This dataset was collected by China's General Administration of Customs (CGAC). For each export or import transaction, the data records the Chinese firm that conducts the transaction (firm name, code, contact information, ownership, etc.), product (at HS8 level), country (destination of export or source of import), time (year and month), value, and transaction type (ordinary or processing trade). We use the import data, and concord the product codes to be in the 1996 version of the Harmonized System (HS) 6 digit product classification (known as HS6) using the official UN concordances.

We distinguish between ordinary imports and processing trade. Ordinary imports refer to non-processing imports that are subject to Chinese import tariffs. There are various types of processing trade. The two most important are: (1) processing with imports (PWI) and (2) processing with assembly (PWA).[10] In both types of processing trade, imports receive tariff exemptions from the Chinese government, and hence they should not be impacted by Chinese import tariffs or relevant uncertainty. Thus we remove them from our analysis and focus on non-processing imports, i.e. ordinary imports.

The tariff data are from the World Bank's WITS (World Integrated Trade Solution) database. We use Chinese MFN tariffs from 1992 (the starting year of Chinese tariffs in WITS) to 2006 (the ending year of our trade data).[11] We include the historical tariffs before 2000 to construct Chinese tariff uncertainty measures, which will be proportional to the log

[10]PWI is when Chinese firms import intermediate inputs from foreign firms, use them to produce final products, and then sell the final products to foreign firms (typically different from the foreign firms that export intermediate inputs to them); both the import and export prices are set based on the negotiations between transaction parties. PWA is when Chinese firms get intermediate inputs directly from foreign firms for free, assemble them to produce final products, and then return them back to the same foreign firms for sale; foreign firms pay Chinese firms a certain processing fee.

[11]We use the data in WITS sourced from the UN TRAINS database as our primary tariff measure, but these data are missing 1995 and 2002. The 2002 tariff schedules are in the WTO Integrated Database (IDB), but no schedules are available for 1995.

difference between current tariffs and a potential worst case scenario captured by the mean tariff from 1992-1999. As with the trade data, we concord the product codes to 1996 revision of the HS classification.

3.2.2 Descriptive and Non-Parametric Evidence

The growth in Chinese imports is substantial from 2000 to 2006. As we describe below, intermediate goods are an important component of the aggregate growth.

Total Chinese imports increased from 225 billion USD in 2000 to 788 billion USD in 2006. Total ordinary imports increased from 133 to 469 billion. Most of the increase occurs after 2003. As we show in Figure 2, the growth is dominated by ordinary imports of intermediate goods and processing trade. Ordinary intermediate imports are about 42% of all imports from 2000-2002 and grow to 45% by 2006. Within the set of ordinary imports, the share of intermediates grows from an average share of 70% in 2000-2002 to 76% by 2006. In contrast, the share of processing trade is about 40% for all of 2000 to 2006.[12]

A similar pattern emerges in cumulative import growth from 2000 to 2006, which is 250%. In Figure 3, we decompose cumulative growth into the contributions from ordinary imports of intermediate goods, ordinary final and capital goods, and processing imports. The largest component in any year is intermediate imports with a contribution of 115% by 2006, or a growth share of 46%.

Changes in the composition of importing firms occur as well. The share of Chinese manufacturing firms that import increased from 12% and 15% during the period. The import share of state-owned enterprises (SOEs) steadily decreased from 54% to 41% of the ordinary imports, and the rest are imports by non-SOEs. The import share of trade intermediaries steadily decreased from 32% to 24% of the ordinary imports, and the rest are imports by manufacturing firms[13]. The reduction of import shares of SOEs and trade

[12]Intermediate inputs are defined based on the UN Broad Economic Categories (BEC) classification, also used in Feng, Li and Swenson (2016).

[13]We identify trade intermediaries from their Chinese names using a method similar to that used in Ahn, Khandelwal and Wei (2010). If a firm name contains Chinese characters equivalent to “export”, “import”,

intermediaries was due to the opening of trade rights to non-stated-owned, small-to-medium sized manufacturing firms after China's WTO entry in December 2001.[14]

The broad aggregate trends in ordinary import growth are corroborated by averages at the product level. Moreover, average growth is higher in products that faced high import tariff uncertainty in 2000. In Table 1(a) we split the sample into high uncertainty products—those in the top tercile of the ranking of the threat tariff to applied tariff ratio, $\tau_i^h/\bar{\tau}_{i,2000}$—and low uncertainty in the bottom two terciles. Import growth is 20 log points higher and variety growth is 19 log points higher in the top tercile of the uncertainty ranking—differences that are statistically significant in a simple t-test.[15]

We find further evidence consistent with the model in two non-parametric visualizations of the data. First, in Figure 4, we run a local polynomial of product level import growth against $\ln \tau_i^h/\bar{\tau}_{i,2000}$ and find a strong positive relationship. Second, in Figure 5, we plot the kernel density of high and low uncertainty product-level import growth. The import growth distribution of high uncertainty products stochastically dominates the low uncertainty products and we easily reject equality of the distributions.

These results may be driven by other product and firm-level shocks to imports that are coincident with China's WTO accession or correlated with high uncertainty products. In the next section we control for some of these possibilities in our regression estimation and test the structural predictions from the model directly.

3.3 Regression Estimates

We now provide regression evidence for the role of TPU in firm-level import values and adoption of new varieties. We focus on intermediate product trade, but also find evidence of our main predictions when pooling over all products.

We start with aggregate evidence on country-product level import values in Table 2. In

"trade", etc., then it is classified as a trade intermediary, otherwise it is classified as a manufacturing firm.

[14]Appendix Table A1 includes further details on the breakdown of total imports and shares by firm type.

[15]We define varieties as the number of firm-HS8-country triplets with positive imports.

columns 1 and 2, we include only the applied tariff and post-WTO accession interaction. We find that the tariff elasticity increases between the pre- and post-WTO periods with either country-time effects (column 1) plus section effects (column 2), in the latter case from 3.6 to 8.6. We then add the uncertainty measure and its interaction with the post-WTO indicator in columns 3 and 4. Uncertainty reduces the value of import intermediates, a key prediction of the model and is partially reversed post-WTO, as shown in the positive and significant differential effects.

In Table 3 we show the firm-level imports of intermediate inputs by aggregated to HS6 product each year. These results are consistent with the aggregate import estimates, but the coefficients differ as they are estimated on firm-level rather than product-level data. The applied tariff elasticity in columns 1 and 2 still increases following WTO accession; a finding robust to including firm, section and time effects or interacted firm-time and section effects. Columns 3-4 run the same specification, but include the uncertainty measure and the post-WTO interaction. We find a negative coefficient of -8 for the uncertainty measure. The effect is partially offset by a significant, positive differential of 4.6 in the post period. Magnitudes are nearly the same for both sets of fixed effects; the firm-time controls for the profit effect on the composite bundle of all the firm inputs.[16]

The key mechanism in the model by which reduced uncertainty increases intermediate imports is the adoption margin for new imported varieties. We observe a reasonable proxy measure of varieties: the number of HS8-exporter observations in each firm-HS6-year cell for which a firm has positive imports. Table 5 uses the log of this variable to proxy for $\ln n_i^{*u}$.[17] In columns 1 and 2, we estimate the coefficients using the intermediate goods sample. Again, the applied tariff elasticity is larger in magnitude post-WTO— going from 0.2 to more than 0.5. The coefficient on uncertainty is about -0.14 and significant in the pre-WTO period.

[16]The model predicts a positive profit effect on variety adoption, which could otherwise bias our coefficients on applied tariffs and uncertainty.

[17]The maximum number of potential varieties measured in this way is limited by the set of available HS8-country categories. Moreover, some countries may not be a feasible source of an input either because it is not produced or trade costs are prohibitively high. For firms near the feasible maximum number of HS8-country varieities within an HS6 there is a downward bias in the estimated coefficients.

The post-WTO interaction term is 0.17 to 0.18, depending on fixed effects, and fully reverses the negative impact effect.

3.4 Robustness

We check robustness to the product intermediate definition, firm sample in the transaction data relative to a more restricted set of production firms. We also show our results are robust to export status of firms and the state ownership.

It's possible that the definition of intermediate goods in the BEC classification is too narrow or arbitrary. Some goods may not neatly fit into discrete categories like final, capital, intermediates across all firms. To check this, we re-run our regressions in Table 4 on the sample of all products. The results are qualitatively similar. However, we find the applied tariff elasticity in the pre-WTO period is substantially lower when pooling over all goods, about -0.8, but only when we also include the uncertainty measure in columns 3 and 4.[18]

The firm information in the trade transactions data does not allow us to distinguish between importers that are production firms, the closest to our model, and importers that are primarily engaged in wholesale or retail activity. To test if our results are robust to this concern, we restricted our trade transactions sample to those that can be matched to firms in the Chinese production census. Table 6 reports the baseline for all intermediate goods trade in column 1. This can be compared to column 2, a sample of all product imports of production firms, and column 3, a sample using production firms' intermediate imports. We continue to find a negative uncertainty affect in the pre-WTO period that is partially reversed following accession. The tariff elasticity also increases after accession, as in our baseline. Comparing the baseline intermediate import results in columns 1 to intermediates in column 3, we see that the sign and significance patterns are the same and the differences coefficient magnitudes are not large enough to generate quantitatively different conclusions.

[18] For the varieties we also extend the sample to include all products and report the results in columns 3 and 4 of Table 5. The tariff elasticity is larger in magnitude in the pre-period, but the coefficients on uncertainty and the post-WTO reversal are quantitatively unchanged.

One possible explanation for the change in tariff elasticity post-WTO is composition. In the model we assume the input elasticity θ is common across all i, but if newly adopted inputs had systematically higher elasticity then it would be reflected in higher post-WTO estimates. To test this we re-estimate Table 3 using only firm-HS6 cells with positive imports in all periods. While this restricts the sample considerably, it yields very similar coefficients to those in the baseline column 3.

Another explanation for our results is that WTO accession reduced TPU on China's market access to other countries. If the Chinese uncertainty measure is correlated with uncertainty reductions in the U.S., then it might reflect higher imports because firms scale up production to serve export markets. We can address this by looking at the export status of importers in our sample. We divide the sample into "Never Exporters", "Always Exporters", and "New Exporters" and run our baseline specification on these sub-samples in Table 7. For all three samples, we find negative uncertainty effects in the pre-WTO period that are partially and significantly reversed following accession.

Next we check whether our results are driven by State Owned Enterprises (SOEs) vs non-SOEs. We split the sample SOE v non-SOE in Table 8 for all product imports. We continue to find evidence that uncertainty was higher pre-WTO and was reduced after accession. The applied tariff coefficients are slightly lower for SOEs.

Finally, we examine how our results depend on the measurement of the threat tariff in Table 9. As an alternative to using the historical mean tariff by product for 1992-1999 (column 1), we use the historical maximum tariff (column 2). The results are qualitatively similar but the magnitudes are slightly different: smaller for the maximum threat tariff. This difference in magnitude is partly because the mean and standard deviation for the max variable are roughly twice of their respective values for the baseline measure. The effects in column 2 remain smaller even after adjusting for standard deviation shocks, which might suggest the historical maximum was less salient than the average measure incorporating liberalization in the late 1990s. We can verify this directly by noting that in column 2 the implied $h = 0.3$, whereas in column 1 the probability of reversal to the mean was $h = 0.57$.

3.5 Quantification

We focus on the baseline estimates for intermediates in Table 3 to provide a simple decomposition of WTO accession effects for imports and varieties. Specifically, we calculate the average impacts from (i) the change in applied tariffs at post accession elasticities and (ii) the increased commitment affecting the reforms undertaken prior to the WTO.

Using the structural import equation and our estimated coefficients we obtain

$$
\begin{aligned}
E_{if} \ln \frac{m_{if}\left(u_{wto}, \tau_{i,wto}\right)}{m_{if}\left(u_{pre}, \tau_{i,pre}\right)} &= \underbrace{\left[\left(\beta_{\tau,wto} - \beta_{h,wto}\right) \cdot E_{if}\left(\Delta \ln \bar{\tau}_i\right)\right]}_{\Delta \text{Tariff}} + \underbrace{\left(\Delta\beta_h / h\right) \times \bar{r}_{pre}}_{(\Delta \text{TPU}) \times \text{Initial Risk}} \quad (31) \\
&= (-2.3) \cdot (-.05) + (4.6/0.57) \times 0.06 \\
&= 0.12 + 0.48
\end{aligned}
$$

Part (i) requires only the observed change in the tariff in this sample, -5 log points, and the difference in the coefficients of the tariff and uncertainty terms, where the latter accounts for any potential reversal that may occur if the WTO did not eliminate uncertainty. The second requires a structural parameter that we recover from the estimates, $h = 0.57$, and a measure of initial risk, which we compute using the historical mean reversal, which was about 6 log points in 2000.[19] We find that the tariff change accounted for about 1/5 of the predicted growth.

We can also compute the counterfactual change if all uncertainty had been eliminated after entry into the WTO, $u_{wto} = 0$. Even in this case, where the change in the tariff upon entry in the WTO is not subject to any reversal, it would only account for 1/3 of the overall

[19] Recall that in the estimation we allow for the beliefs to include some probability that the tariffs revert to their (ln) historical mean in each i with probability h and some other common value lnτ with probability $1 - h$ .To obtain the full pre risk we can consider alternative values for this. A neutral benchmark is $\ln \tau = E \ln \tau_i^h$ so the overall mean of the risk is simply $\bar{r}_{pre} = E \ln \left(\tau_i^h / \tau_{i,pre}\right)$. Since we recover h we can consider alternatives such as $\ln \tau = E \ln \tau_i^{\max}$ so $\bar{r}_{pre} = hE \ln \left(\tau_i^h\right) + (1-h) E \ln \left(\tau_i^{\max}\right) - E \ln \left(\tau_{i,pre}\right)$ (= 0.1 given $h = .57$)

growth, $\left[\beta_{\tau,wto}\right]_{u_{wto}=0} \cdot E_{if}\left(\Delta \ln \bar{\tau}_i\right) / \ E_{if} \ln \frac{m_{if}(u_{wto},\bar{\tau}_{i,wto})}{m_{if}(u_{pre},\bar{\tau}_{i,pre})}\Big|_{u_{wto}=0} = 1/3.$[20]

A similar calculation using the variety specification in Table 9 yields a share of growth accounted by the tariff change close to 1/2, it is larger in part because the variety estimates imply an elimination of uncertainty.[21]

This preliminary quantification indicates that at least half of the import and variety growth effect of accession was from locking in previous tariff reductions by lowering the belief they would be reversed.

4 Conclusion

Commitments to trade liberalization and trade agreements induce firms to make investments in new trade relationships and upgrades. We consider this motive in the context of a firm's decision to adopt imported inputs when trade policy is uncertain.

Most research has focused on improved market access for exporters through reduced policy uncertainty in trade agreements. Our approach builds on and extends this research to imports when the future path of import tariffs is uncertain and there are sunk costs of adoption. We show that reductions in trade policy uncertainty that lock-in applied tariffs

[20]To see this we compute

$$\begin{aligned} E_{if} \ln \frac{m_{if}\left(u_{wto}, \bar{\tau}_{i,wto}\right)}{m_{if}\left(u_{pre}, \bar{\tau}_{i,pre}\right)}|_{u_{wto}=0} &= \beta_{\tau,wto}|_{u_{wto}=0} \cdot E_{if}\left(\Delta \ln \bar{\tau}_i\right) + \left(\Delta\beta_h/h\right)|_{u_{wto}=0} \cdot \bar{r}_{pre} \\ &= -8.4 \cdot (-.05) + (7.97/0.57) \cdot .06 \end{aligned}$$

where $\beta_{\tau,wto}|_{u_{wto}=0} \equiv -(\theta-1)\frac{(1-s_0)}{s_0} = \beta_\tau^m + \beta_h^m(1-h)/h$ and $\left(\Delta\beta_h/h\right)|_{u_{wto}=0} \equiv \frac{u_{pre}}{1+u_{pre}}(\theta-1)\frac{(1-s_0)^2}{s_0} = -\beta_{h,pre}/h$.

[21]We can still apply the expression in (31) to obtain $E_{if} \ln \frac{n_{if}(u_{wto},\bar{\tau}_{i,wto})}{n_{if}(u_{pre},\bar{\tau}_{i,pre})}$ but the structural parameters now refer to n. In mapping those parameters to the estimates we must account for the fact that we employ a proxy, the number of HS8-country, $\ln\tilde{n} = b\ln n$ and expect that its relationship to the true measure is mediated by $b > 0$. We expect that $b < 1$, e.g. a firm that already imports from all available hs8-country may still increase variety (at firm level) but $\tilde{n}$ will show zero growth. Thus, if all the coefficients in the proxy specification are scaled by b we can only compute $bE_{if} \ln \frac{n_{if}(u_{wto},\bar{\tau}_{i,wto})}{n_{if}(u_{pre},\bar{\tau}_{i,pre})}$ but any ratio of coefficients will cancel this factor b. So we can use ratios to compute $h = \frac{0.18}{0.18-(-.34)} = 0.34$ and the share of growth accounted for by the tariff for true varieties based on the proxy estimates: $\left[b \cdot \left(\beta_{\tau,wto} - \beta_{h,wto}\right) \cdot E_{if}\left(\Delta \ln \bar{\tau}_i\right)\right] / \left[b \cdot E_{if} \ln \frac{n_{if}(u_{wto},\bar{\tau}_{i,wto})}{n_{if}(u_{pre},\bar{\tau}_{i,pre})}\right] = \left(-.57 \cdot (-.05)\right) / \left(-.57 \cdot (-.05) + (.18/.34) \cdot .06\right) = 0.47.$

can increase adoption of imported varieties.

We estimate the model using Chinese firm-level data before and after China's accession to the WTO. Our estimates suggest accession reduced uncertainty and that WTO commitments for China's own import tariffs help explain its dramatic increase in imports from 2000-2006. We also show that imports are more responsive to continued tariff reductions after accession because importers believed a reversion to historically higher tariffs was less likely.

An important caveat is that WTO accession reduced TPU, but it did not eliminate it. The recent trade war between the US and China, Brexit, and other trade tensions are likely to reduce some of the credibility of WTO commitments and existing trade agreements. Such credibility takes time to rebuild. According to our model and findings, the recent trade tensions could continue to depress imported inputs even after if recent increases in tariffs are reversed.

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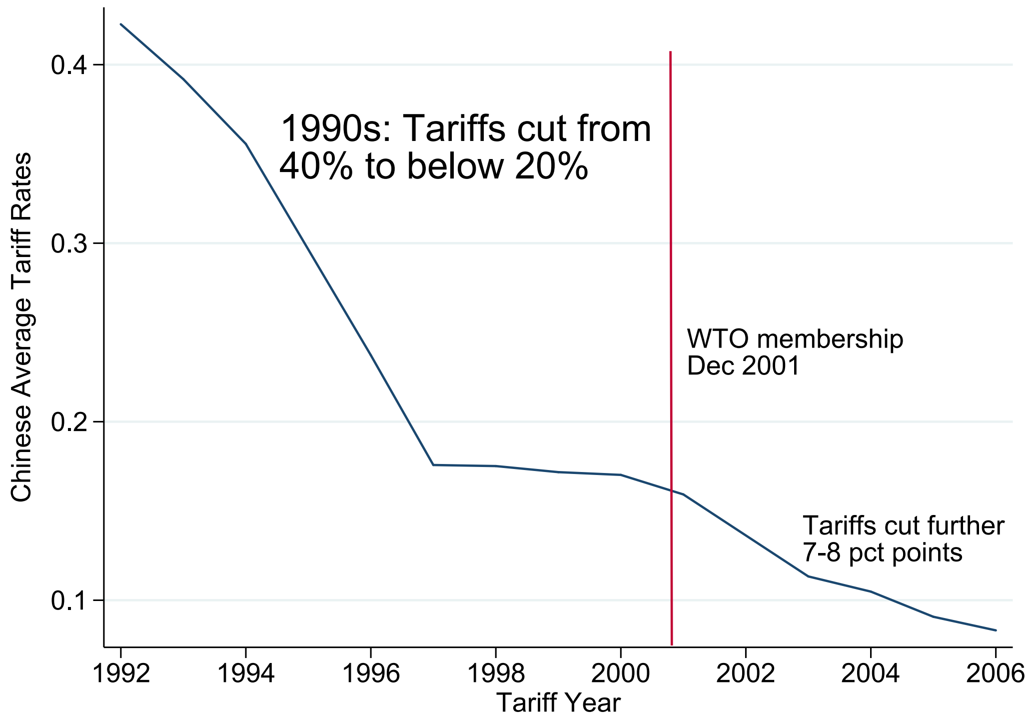
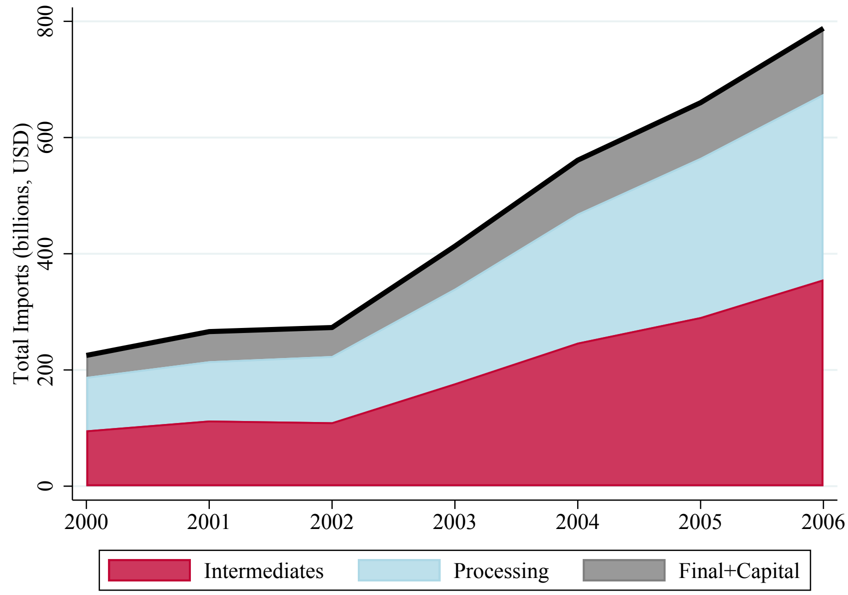
5 Figures

Figure 1: China's Average Import Tariff (1992-2006)



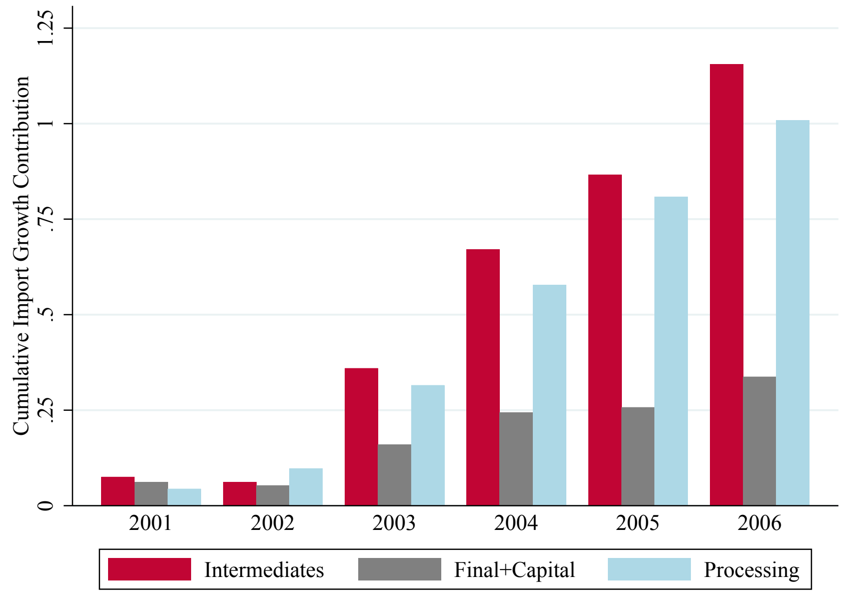
Notes: Authors' calculations from UN TRAINS and WTO data. See text for further description.

Figure 2: Aggregate Chinese Imports by Firm-Product Characteristics (2000-2006)



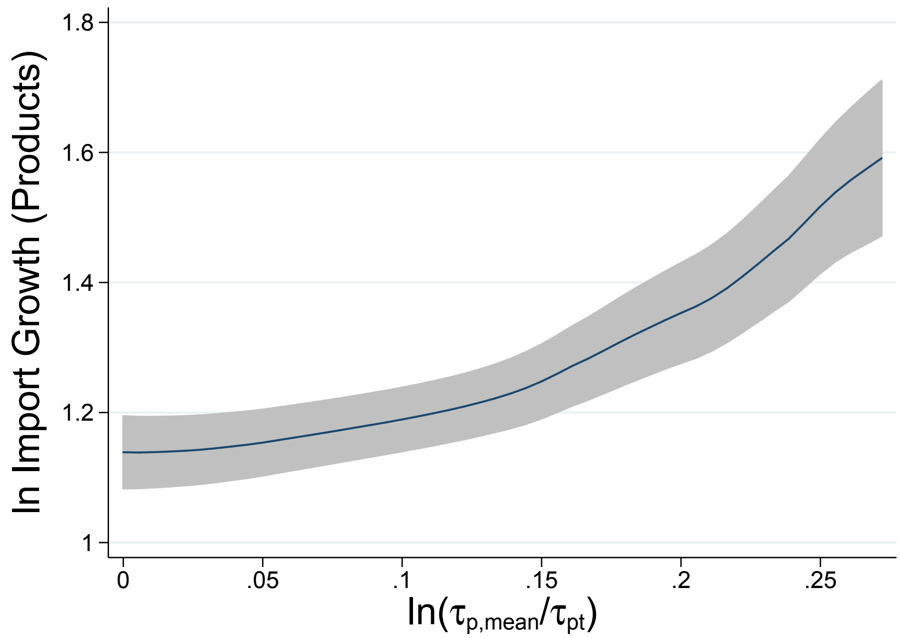
Notes: Authors' calculations from Chinese trade transactions data. Values are in billions of US dollars. Processing and ordinary imports identified by transaction identifiers. Ordinary imports concorded at product level in intermediate, final, and capital goods using the UN BEC classification. See text for further description.

Figure 3: Cumulative Contribution to Aggregate Import Growth by Firm-Product Characteristics (2000-2006)



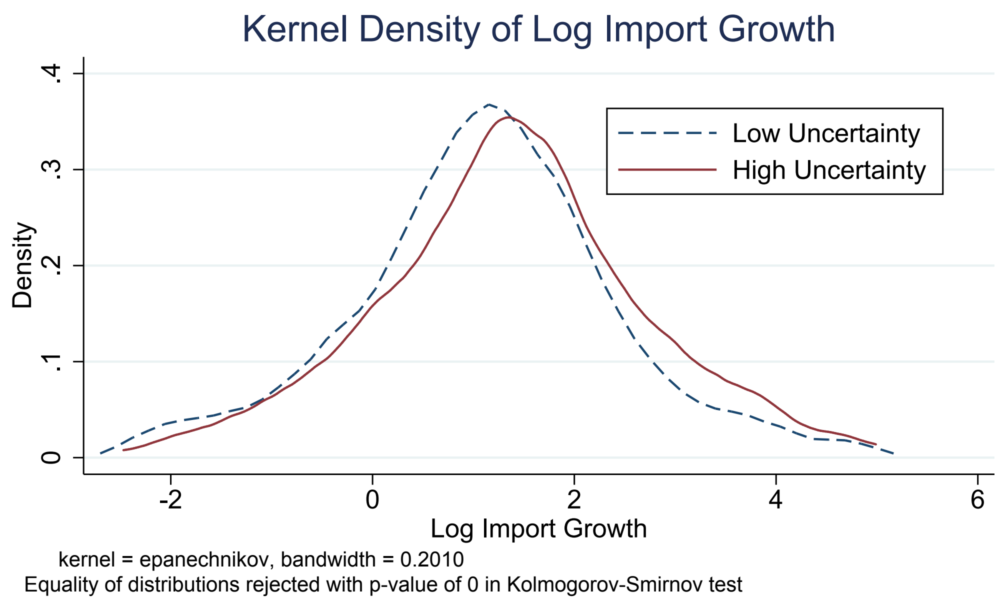
Notes: Authors' calculations from Chinese trade transactions data. Arithmetic growth rate contribution by each growth relative to total imports in 2000. Bars within each year sum to cumulative aggregate growth. Processing and ordinary imports identified by transaction identifiers. Ordinary imports concorded at product level in intermediate, final, and capital goods using the UN BEC classification. See text for further description.

Figure 4: Relationship between Product-level Import Growth and Uncertainty (2000-2006)



Notes: Local polynomial of log growth rate in ordinary imports at product level between 2000 and 2006 on $\ln \tau^h_{i,mean}/\tau_{i,2000}$ where $\tau_{i,mean}$ is the average tariff for product i from 1992-1999 and $\tau i, 2000$ is applied tariff in 2000.

Figure 5: Distributions of Import Growth in High vs. Low Uncertainty Products (2000-2006)



Notes: Kernel density of log growth rate in ordinary imports at product level between 2000 and 2006. High uncertainty products in top tercile of the ranking of $\ln \tau^h_{i,mean}/\tau_{i,2000}$. Low uncertainty in the bottom two terciles. $\tau_{i,mean}$ is the average tariff for product i from 1992-1999 and $\tau i, 2000$ is applied tariff in 2000.

A Data and Estimation Appendix

A.1 Data sources and definitions

- *Tariff:* Log of 1 plus the Chinese statutory MFN tariff rate aggregated to the HS6 level in a year during the period 2000-2006. HS6 codes are concorded to the 1996 version. Source: TRAINS via WITS.

- *Uncertainty:* Measure of uncertainty from the model $\ln(\tau_h/\tau_t)$. τ_h (high tariff, i.e., threat tariff) is (1 plus) Chinese average MFN tariff rate (in the baseline regressions with historical mean tariff as threat tariff) or Chinese maximum MFN tariff rate (in the robustness checks with historical max tariff as threat tariff) during the pre-WTO period 1992-1999 for an HS6 product. τ_t is and (1 plus) current year t ($t = 2000$ for the pre-WTO uncertainty measure) MFN tariff rate of the HS6 product.

- *Imports:* log of Chinese ordinary (non-processing) import value at the HS6-country-year level, or the HS6-year level, or the firm-HS6-year level (same as level of regressions) in a year during the period 2000-2006. Source: Chinese transaction level import data from the Chinese Customs.

- *Number of Import Varieties:* log of Chinese ordinary (non-processing) import varieties (HS8-country combinations) at the HS6-year level or firm-HS6-year level (same as level of regressions) in a year during the period 2000-2006. Source: Chinese transaction level import data from the Chinese Customs.

- *Import Dummy:* Chinese country-HS6-year level or firm-HS6-year level (same as level of regressions) ordinary (non-processing) import dummy that is equal to 1 if import value is positive, and 0 otherwise, in a year during the period 2000-2006. Source: Chinese transaction level import data from the Chinese Customs.

- *Post Dummy:* Post-WTO dummy that is equal to 1 for years since 2002, and 0 otherwise.

- *SOEs vs. Non-SOEs:* State-owned enterprises and non-state-owned enterprises defined in Chinese transaction level import data. Source: Chinese transaction level import data from the Chinese Customs.

- *Trade Intermediaries vs. Manufacturing Firms:* Firm categories based on names of Chinese firms using a method similar to that used in Ahn, Khandelwal and Wei (2011). If a firm name contains Chinese characters equivalent to export, import, trade, etc., then it is classified as a trade intermediary, otherwise it is classified as a manufacturing firm. Source: Chinese transaction level import data from the Chinese Customs.

- *Production Firms:* Firm in Chinese transaction level import data that could be matched to Chinese firm level production data using firm information of names, zip codes and telephone numbers. Source: Chinese transaction level import data from the Chinese Customs and firm level production data from the Chinese Bureau of Statistics.

- *Intermediates/Final Products/Capital Goods:* Product categories based on UN BEC classification. Source: UN BEC classification in Feng, Li and Swenson (2016).
- *cic4:* 4-digit Chinese industry classification. Source: Chinese firm level production data from the Chinese Bureau of Statistics.
- *section:* The UN defined "sections", which are coherent groups of HS-2 industries, as described in http://unstats.un.org/unsd/tradekb/Knowledgebase/HS. Source: United Nations.

B Theory Appendix

B.1 Profit concavity

Result: $\alpha\left(\frac{\sigma-1}{\theta-1}\right)<1$ implies that $\pi(z)$ is strictly concave.

Proof: The second derivatives and cross-partials of $\pi(z)$ can be written as $\pi_{z_iz_i}(z)=ab_i^2\left[1-\left(\alpha_i\frac{\sigma-1}{\theta-1}\right)^{-1}\right]$ and $\pi_{z_iz_j}(z)=ab_ib_j$, respectively, where $a=\pi(z)\left(\frac{\sigma-1}{\theta-1}\right)^2$ and $b_i=\frac{\alpha_i}{z_i}$. Let $\mathbf{b}$ denote an $N\times 1$ column vector whose elements are b_i, and let $\mathbf{A}$ denote an $N\times N$ diagonal matrix with $-b_i^2\left(\alpha_i\frac{\sigma-1}{\theta-1}\right)^{-1}$ on the diagonal. Thus, the Hessian of π can be written as $\mathbf{H}=a\left[\mathbf{A}+\mathbf{b}\mathbf{b}^T\right]$. Letting $\mathbf{H}_k$ denote the kth order leading principal submatrix of $\mathbf{H}$, we can likewise write $\mathbf{H}_k=a\left[\mathbf{A}_k+\mathbf{b}_k\mathbf{b}_k^T\right]$ for $k=1,2,...,N$. The kth leading principal minor is,

$$|\mathbf{H}_k|=a\left[1+\mathbf{b}_k^T\mathbf{A}_k^{-1}\mathbf{b}_k\right]|\mathbf{A}_k|=a\left[1-\sum_{i=1}^{k}\alpha_i\left(\frac{\sigma-1}{\theta-1}\right)\right]\prod_{i=1}^{k}\left[-b_i^2\left(\alpha_i\frac{\sigma-1}{\theta-1}\right)^{-1}\right]$$

where the first equality follows from the matrix determinant lemma. The concavity holds if $\mathbf{H}$ is negative definite, which requires that $|\mathbf{H}_k|<0$ for k odd and $|\mathbf{H}_k|>0$ for k even, and a sufficient condition for this is $1-\sum_{i=1}^{k}\alpha_i\left(\frac{\sigma-1}{\theta-1}\right)>0$ for all k, or $\alpha\left(\frac{\sigma-1}{\theta-1}\right)<1$. QED

B.2 Derivation of z

Derivation of $z_i^{\frac{1}{1-\theta}}x_i=\alpha_i(\sigma-1)\pi$

The firm minimizes lagrangian $\sum z_i^{\frac{1}{1-\theta}}x_i+l+\lambda\left(y-\varphi l^{1-\alpha}\Pi_{i=1}^{N}x_i^{\alpha_i}\right)$. First-order conditions are: $z_i^{\frac{1}{1-\theta}}x_i=\alpha_i\lambda y$ and $l=(1-\alpha)\lambda y$. Summing the FOCs gives: $\sum z_i^{\frac{1}{1-\theta}}x_i+l=\lambda y$ or $\lambda=\left(\sum z_i^{\frac{1}{1-\theta}}x_i+l\right)/y=c$. Thus, $z_i^{\frac{1}{1-\theta}}x_i=\alpha_i yc$. Replacing y with demand (1) and using $p=\frac{\sigma}{(\sigma-1)}c$, we have $z_i^{\frac{1}{1-\theta}}x_i=\alpha_iE\left(\frac{\sigma}{(\sigma-1)}c\right)^{-\sigma}c$. Whereas operating profit is: $\pi=(p-c)y=\left(\frac{\sigma}{(\sigma-1)}c-c\right)E\left(\frac{\sigma}{(\sigma-1)}c\right)^{-\sigma}=\frac{1}{(\sigma-1)}E\left(\frac{\sigma}{(\sigma-1)}c\right)^{-\sigma}c$. Substitution yields, $z_i^{\frac{1}{1-\theta}}x_i=\alpha_i(\sigma-1)\pi$. QED

B.3 Ranking of entry

A sufficient condition for (n^u,n^{*u}) (optimally chosen under uncertainty in the current state τ^l) to remain unchanged after a switch to τ^h is either $\rho_i^l<\rho_i^h<1$ or $1<\rho_i^l<\rho_i^h$.

Proof: As argued in the text we need only rule out that the optimal n does not increase when the price is increased. If $\rho_i^l>1$, then $i\notin M$, and we have $n_i>0$ and $n_i^*=0$. In this case, a switch to τ^h would lower the marginal profit with respect to n_i as it lower profits (negative income effect), but the change in τ_i as no effect (no substitution effect). For $i\in M$, we have $n_i = n_i^0$ and $n_i^* > 0$. If the price switches to τ^h, then the necessary and sufficient condition for the new optimum n_i' to be no greater than n_i^0 for all $i \in M$ is

$$\pi(n^u, n^{*u}; \tau^h)\alpha_i B \frac{1}{n_i^0 + n^{*u}\left(\tau_i^h\right)^{1-\theta}} \leq 1 \tag{32}$$

However, as there is no incentive to increase n^{*u} after a shift to τ^h, it must be that

$$\pi(n^u, n^{*u}; \tau^h)\alpha_i B \frac{1}{n_i^0 + n^{*u}\left(\tau_i^h\right)^{1-\theta}} < \rho_i^h$$

Thus, if $\rho_i^h < 1$, then condition (29) is satisfied. QED

B.4 Derivation of extensive margin under TPU

Here we show how to derive equation (24)

The first order condition is:

$$\frac{1}{1+u}\frac{\pi(z^l)\alpha_i B^*}{n_i^0\left(\tau_i^l\right)^{\theta-1} + n_i^{*u}} + \frac{u}{1+u}\frac{\pi(z^h)\alpha_i B^*}{n_i^0\left(\tau_i^h\right)^{\theta-1} + n_i^{*u}} = 1$$

Use $\frac{B^*}{B}\rho_i \equiv \tau_i^{\theta-1}$

$$\frac{1}{1+u}\frac{\pi(z^l)\frac{\alpha_i B}{n_i^0}}{\frac{B^*}{B}\rho_i^l + \frac{n_i^{*u}}{n_i^0}} + \frac{u}{1+u}\frac{\pi(z^h)\frac{\alpha_i B}{n_i^0}}{\frac{B^*}{B}\rho_i^h + \frac{n_i^{*u}}{n_i^0}} = \frac{B}{B^*}$$

$$\frac{1}{1+u}\pi(z^l)\frac{\alpha_i B}{n_i^0} + \frac{u}{1+u}\pi(z^h)\frac{\alpha_i B}{n_i^0}\frac{\left(\rho_i^l + \frac{B}{B^*}\frac{n_i^{*u}}{n_i^0}\right)}{\rho_i^h - \rho_i^l + \left(\rho_i^l + \frac{B}{B^*}\frac{n_i^{*u}}{n_i^0}\right)} = \rho_i^l + \frac{B}{B^*}\frac{n_i^{*u}}{n_i^0}$$

Use $\eta_i = \bar{\pi}\alpha_i B / n_i^0$

$$\frac{1}{1+u}\frac{\pi(z^l)}{\bar{\pi}}\eta_i + \frac{u}{1+u}\frac{\pi(z^h)}{\bar{\pi}}\eta_i\frac{\left(\rho_i^l + \frac{B}{B^*}\frac{n_i^{*u}}{n_i^0}\right)}{\rho_i^h - \rho_i^l + \left(\rho_i^l + \frac{B}{B^*}\frac{n_i^{*u}}{n_i^0}\right)} = \rho_i^l + \frac{B}{B^*}\frac{n_i^{*u}}{n_i^0}$$

Let $a = \frac{1}{1+u}\frac{\pi(z^l)}{\bar{\pi}}\eta_i$, $b = \frac{u}{1+u}\frac{\pi(z^h)}{\bar{\pi}}\eta_i$, $c = \rho_i^h - \rho_i^l$. and $x = \rho_i^l + \frac{n_i^*}{n_i^0}\frac{B}{B^*}$. Then,

$$a + b\frac{x}{c+x} = x$$

$$ac + ax + bx = xc + x^2$$

$$0 = -ac - x\left(a + b - c\right) + x^2$$

$$x = \frac{\left(a + b - c\right) \pm \sqrt{\left(a + b - c\right)^2 + 4ac}}{2}$$

$$x = a + b - \frac{\left(a + b + c\right) \pm \sqrt{\left(a + b\right)^2 + 2\left(a + b\right)c + c^2 - 4bc}}{2}$$

There two roots, one negative and one positive. As the negative root would imply negative varieties, we use

$$x = a + b - \frac{\left(a + b + c\right) - \sqrt{\left(a + b + c\right)^2 - 4bc}}{2}$$

After some algebra we obtain

$$x = a + b - \left(a + b + c\right)\frac{1 - \sqrt{1 - \frac{4bc}{(a+b+c)^2}}}{2}$$

Let $\psi_i = \frac{1-\sqrt{1-\frac{4bc}{(a+b+c)^2}}}{2} = \frac{1}{2} - \frac{1}{2}\left(1 - \frac{4bc}{(a+b+c)^2}\right)^{1/2}$

$$x = \left(1 - \psi_i\right)\left(a + b\right) - \rho_i^h\psi_i + \rho_i^l\psi_i$$

$$\rho_i^l + \frac{n_i^*}{n_i^0}\frac{B}{B^*} = \left(1 - \psi_i\right)\left(a + b\right) - \rho_i^h\psi_i + \rho_i^l\psi_i$$

$$\frac{n_i^*}{n_i^0}\frac{B}{B^*} = \left(1 - \psi_i\right)\left(a + b\right) - \left(1 - \psi_i\right)\rho_i^l - \rho_i^h\psi_i$$

$$n_i^* = n_i^0\frac{B^*}{B}\left\{\left(1 - \psi_i\right)\left(a + b\right) - \left(1 - \psi_i\right)\rho_i^l - \rho_i^h\psi_i\right\}$$

and

$$\psi_i = \frac{1}{2}\left(1 - \left(1 - \frac{4\frac{u}{1+u}\frac{\pi(z^h)}{\bar{\pi}}\eta_i\left(r_i - 1\right)\rho_i^l}{\left(\eta_i\Gamma + \left(r_i - 1\right)\rho_i^l\right)^2}\right)^{1/2}\right)$$

where $\Gamma \equiv \frac{\pi(z^l)+u\pi(z^h)}{(1+u)\bar{\pi}}$ and $r_i \equiv \rho_i^h/\rho_i^l$.

B.5 Approximation

Derivation of Equations (26)-(28)

Start with $n_i^{*u} = \left(n_i^0 \frac{B^*}{B}\right)\left[\left(1-\psi_i\right)\eta_i\Gamma - \left(1-\psi_i\right)\rho_i^l - \psi_i r_i \rho_i^l\right]$, where $\Gamma \equiv \frac{\pi(z^l)+u\pi(z^h)}{(1+u)\bar{\pi}}$ and $r_i \equiv \rho_i^h/\rho_i^l$. To obtain a first-order approximation, we will differentiate $\ln n_i^{*u}$ with respect to $\ln \rho_i^l$, $\ln r_i$, $\ln \eta_i$ and $\ln \Gamma$, and evaluate at $\rho_i^l = \rho_i^h = \rho_0$ (i.e., $r_i = 1$) and $\eta_i \equiv \eta_0$ for all $i \in M$.

First, note that $\Gamma_0 \equiv \Gamma \mid_{\rho_0} = \frac{\pi(z^l)}{\bar{\pi}} = \rho_0^{\frac{-\alpha_M}{\alpha}(\Theta-1)}$, and $n_{i0}^{*u} \equiv n_i^{*u} \mid_{\rho_0} = \left(n_i^0 \frac{B^*}{B}\right)\left[\eta_0\Gamma_0 - \rho_0\right]$. Second, recall that $\psi_i = \frac{1}{2} - \frac{1}{2}\left\{1 - 4\frac{u}{1+u}\frac{\pi(z^h)}{\bar{\pi}}\eta_i\left(r_i-1\right)\rho_i^l\left[\eta_i\Gamma + \left(r_i-1\right)\rho_i^l\right]^{-2}\right\}^{1/2}$ and thus,

$$\frac{\partial \psi_i}{\partial r_i} \mid_{\rho_0} = \frac{u}{1+u}\frac{\rho_0}{\eta_0\Gamma_0}$$

$$\frac{\partial \psi_i}{\partial \rho_i^l} \mid_{\rho_0} = \frac{\partial \psi_i}{\partial \eta_i} \mid_{\rho_0} = \frac{\partial \psi_i}{\partial \Gamma} \mid_{\rho_0} = 0$$

Differentiation of $\ln n_i^{*u}$ yields,

$$\frac{\partial \ln n_i^{*u}}{\partial \ln x} = \frac{\partial n_i^{*u}}{\partial x}\frac{x}{n_i^{*u}}$$

$$n_i^{*u} = \left(n_i^0 \frac{B^*}{B}\right)\left[\left(1-\psi_i\right)\eta_i\Gamma - \left(1-\psi_i\right)\rho_i^l - \psi_i r_i \rho_i^l\right]$$

$$\frac{\partial \ln n_i^{*u}}{\partial \ln \rho_i^l} \mid_{\rho_0} = \frac{-\rho_0}{\eta_0\rho_0^{\frac{-\alpha_M}{\alpha}(\Theta-1)} - \rho_0}$$

$$s_0^* = 1 - \frac{\rho_0}{\eta_0}\Pi_{j\in M}\left(\rho_0^{\frac{\alpha_i}{\alpha}(\Theta-1)}\right)$$

$$\frac{\rho_0}{\eta_0}\Pi_{j\in M}\left(\rho_0^{\frac{\alpha_i}{\alpha}(\Theta-1)}\right) = 1 - s_0^*$$

$$\frac{\rho_0}{(1-s_0^*)} = \eta_0\Pi_{j\in M}\left(\rho_0^{-\frac{\alpha_i}{\alpha}(\Theta-1)}\right)$$

$$\frac{\partial \ln n_i^{*u}}{\partial \ln \rho_i^l} \mid_{\rho_0} = \frac{-\left(1-s_0^*\right)}{s_0^*}$$

$$\frac{\partial \ln n_i^{*u}}{\partial \ln r_i} \mid_{\rho_0} = \frac{-\left(1-s_0^*\right)}{s_0^*}\frac{u}{1+u}$$

$$n_i^{*u} = \frac{[\eta_0]}{\left[\eta_0 \Gamma - \rho_0^l\right]}$$

$$\frac{\partial \ln n_i^{*u}}{\partial \ln \Gamma} |_{\rho_0} = \frac{\eta_0 \rho_0^{\frac{-\alpha_M}{\alpha}(\Theta-1)}}{\eta_0 \rho_0^{\frac{-\alpha_M}{\alpha}(\Theta-1)} - \rho_0} = \frac{1}{s_0^*}$$

$$\frac{\partial \ln n_i^{*u}}{\partial \ln \eta_i} |_{\rho_0} = \frac{\eta_0 \rho_0^{\frac{-\alpha_M}{\alpha}(\Theta-1)}}{\eta_0 \rho_0^{\frac{-\alpha_M}{\alpha}(\Theta-1)} - \rho_0} = \frac{1}{s_0^*}$$

If we are not interested in estimating the aggregate effect of tariff uncertainty, we can stop here, with

$$\ln n_i^{*u} \approx \ln n_{i0}^{*u} + \frac{1}{s_0} \ln\left(\frac{\eta_i}{\eta_0}\right) - \frac{1 - s_0}{s_0} \ln\left(\frac{\rho_i^l}{\rho_0}\right) - \frac{1 - s_0}{s_0} \frac{u}{1+u} \ln\left(\frac{\rho_i^h}{\rho_i^l}\right) + \frac{1}{s_0} \ln\left(\frac{\Gamma}{\Gamma_0}\right)$$

where

$$\ln n_{i0}^{*u} = \ln n_{i0}^{*} = \ln\left(n_i^0 \frac{B^*}{B}\right) + \ln\left(\rho_0 \frac{s_0^*}{1 - s_0^*}\right)$$

and

$$\ln\left(\frac{\eta_i}{\eta_0}\right) = \ln \bar{\pi} + \ln\left(\frac{\alpha_i B}{n_i^0 \eta_0}\right)$$

as $\ln(\Gamma/\Gamma_0)$ does not vary across inputs.

To estimate the aggregate effect of tariff uncertainty, we must account for the fact that Γ is a function of the entire vector of tariffs, low and high. Write Γ as a function of $\pi(z^l)/\bar{\pi}$ and $\pi(z^h)/\pi(z^l)$ as follows,

$$\Gamma = \frac{\pi(z^l)}{\bar{\pi}} \frac{1 + u \frac{\pi(z^h)}{\pi(z^l)}}{1+u}$$

For D, $n_i^u = \bar{\pi} \alpha_i B \Gamma$ thus,

$$z_i = \bar{\pi} \alpha_i B \Gamma$$

For M, $n_i^{*u} = \left(n_i^0 \frac{B^*}{B}\right) \left[(1 - \psi_i) \eta_i \Gamma - (1 - \psi_i) \rho_i^l - \psi_i r_i \rho_i^l\right]$

$$z_i^l = n_i^0 + \left(n_i^0 \frac{B^*}{B}\right) \left[(1 - \psi_i) \eta_i \Gamma - (1 - \psi_i) \rho_i^l - \psi_i r_i \rho_i^l\right] \left(\tau_i^l\right)^{1-\theta}$$

$$z_i^l = n_i^0 - n_i^0\left(\frac{B^*}{B}\right)\left(\tau_i^l\right)^{1-\theta}\rho_i^l + \left(n_i^0\frac{B^*}{B}\right)\left[\left(1-\psi_i\right)\eta_i\Gamma + \psi_i\rho_i^l - \psi_i r_i\rho_i^l\right]$$

Note $\left(\frac{B^*}{B}\right)\left(\tau_i^l\right)^{1-\theta}\rho_i^l = 1$

$$z_i^l = \left(n_i^0\frac{B^*}{B}\right)\left[\left(1-\psi_i\right)\eta_i\Gamma - \psi_i\left(r_i-1\right)\rho_i^l\right]\left(\tau_i^l\right)^{1-\theta}$$

$$z_i^l = \bar{\pi}\alpha_i B\Gamma\left[\frac{1-\psi_i}{\rho_i^l} - \frac{\psi_i\left(r_i-1\right)}{\eta_i\Gamma}\right]$$

$$\frac{\pi(z^l)}{\bar{\pi}} = \frac{\Pi_{i\in D}\left[\bar{\pi}\alpha_i B\Gamma\right]^{\frac{\alpha_i(\sigma-1)}{\theta-1}}\Pi_{i\in M}\left\{\bar{\pi}\alpha_i B\Gamma\left[\frac{1-\psi_i}{\rho_i^l} - \frac{\psi_i(r_i-1)}{\eta_i\Gamma}\right]\right\}^{\frac{\alpha_i(\sigma-1)}{\theta-1}}}{\Pi_{i\in D}\left(\bar{\pi}\alpha_i B\right)^{\frac{\alpha_i(1-\sigma)}{1-\theta}}\Pi_{i\in M}\left(\bar{\pi}\alpha_i B\right)^{\frac{\alpha_i(1-\sigma)}{1-\theta}}}$$

which simplifies to,

$$\frac{\pi(z^l)}{\bar{\pi}} = \Gamma^{\frac{\alpha(\sigma-1)}{\theta-1}}\Pi_{i=1}^M\left[\frac{1-\psi_i}{\rho_i^l} - \frac{\psi_i\left(r_i-1\right)}{\eta_i\Gamma}\right]^{\frac{\alpha_i(\sigma-1)}{\theta-1}}$$

Similarly, we can write,

$$z_i^h = \left(n_i^0\frac{B^*}{B}\right)\left(\tau_i^l\right)^{1-\theta}\rho_i^l + \left(n_i^0\frac{B^*}{B}\right)\left[\left(1-\psi_i\right)\eta_i\Gamma - \left(1-\psi_i\right)\rho_i^l - \psi_i r_i\rho_i^l\right]\left(\tau_i^h\right)^{1-\theta}$$

$$\frac{\pi(z^h)}{\pi(z^l)} = \Pi_{i\in M}\left(\frac{\rho_i^l + \left[\left(1-\psi_i\right)\eta_i\Gamma - \left(1-\psi_i\right)\rho_i^l - \psi_i r_i\rho_i^l\right]\left(r_i\right)^{-1}}{\left(1-\psi_i\right)\eta_i\Gamma - \psi_i\left(r_i-1\right)\rho_i^l}\right)^{\frac{\alpha_i(\sigma-1)}{\theta-1}}$$

which simplifies to,

$$\frac{\pi(z^h)}{\pi(z^l)} = \Pi_{i\in M}\left[\left(\frac{\left(r_i-1\right)\rho_i^l}{\left(1-\psi_i\right)\eta_i\Gamma - \psi_i\left(r_i-1\right)\rho_i^l} + 1\right)\frac{1}{r_i}\right]^{\frac{\alpha_i(\sigma-1)}{\theta-1}}$$

We now differentiate Γ first with respect to ρ_i^l:

$$\begin{aligned}\frac{\partial\Gamma}{\partial\rho_i^l}\mid_{\rho_0} &= \frac{\partial}{\partial\rho_i^l}\frac{\pi(z^l)}{\bar{\pi}} + \Gamma_0\frac{u}{1+u}\frac{\partial}{\partial\rho_i^l}\frac{\pi(z^h)}{\pi(z^l)} \\ &= \frac{\alpha\left(\sigma-1\right)}{\left(\theta-1\right)}\frac{\partial\Gamma}{\partial\rho_i^l} - \frac{\alpha_i\left(\sigma-1\right)}{\theta-1}\frac{\Gamma_0}{\rho_0}\end{aligned}$$

$$\frac{\partial \Gamma}{\partial \rho_i^l}\frac{\rho_0}{\Gamma_0} = -\frac{\alpha_i}{\alpha}\left(\Theta - 1\right)$$

Next with respect to r_i:

$$\frac{\partial \Gamma}{\partial r_i} = \frac{\partial}{\partial r_i}\frac{\pi(z^l)}{\bar{\pi}} + \Gamma_0 \frac{u}{1+u}\frac{\partial}{\partial r_i}\frac{\pi(z^h)}{\pi(z^l)}$$

$$\frac{\pi(z^l)}{\bar{\pi}} = \Gamma^{\frac{\alpha(\sigma-1)}{\theta-1}} \Pi_{i=1}^M \left[\frac{1-\psi_i}{\rho_i^l} - \frac{\psi_i \left(r_i - 1\right)}{\eta_i \Gamma}\right]^{\frac{\alpha_i(\sigma-1)}{\theta-1}}$$

$$\frac{\partial}{\partial r_i}\frac{\pi(z^l)}{\bar{\pi}} = \frac{\alpha\left(\sigma-1\right)}{\theta-1}\frac{\partial \Gamma}{\partial r_i} - \frac{\alpha_i\left(\sigma-1\right)}{\theta-1}\Gamma_0 \frac{u}{1+u}\frac{\rho_0}{\eta_0 \Gamma_0}$$

$$\frac{\pi(z^h)}{\pi(z^l)} = \Pi_{i\in M}\left[\left(\frac{\left(r_i-1\right)\rho_i^l}{\left(1-\psi_i\right)\eta_i \Gamma - \psi_i\left(r_i - 1\right)\rho_i^l} + 1\right)\frac{1}{r_i}\right]^{\frac{\alpha_i(\sigma-1)}{\theta-1}}$$

$$\frac{\partial}{\partial r_i}\frac{\pi(z^h)}{\pi(z^l)} = \frac{\alpha_i\left(\sigma-1\right)}{\theta-1}\left(-1 + \frac{\rho_0}{\eta_0 \Gamma_0}\right)$$

$$\frac{\partial \Gamma}{\partial r_i} = \frac{\alpha\left(\sigma-1\right)}{\theta-1}\frac{\partial \Gamma}{\partial r_i} - \frac{\alpha_i\left(\sigma-1\right)}{\theta-1}\Gamma_0 \frac{u}{1+u}\frac{\rho_0}{\eta_0 \Gamma_0} + \Gamma_0 \frac{u}{1+u}\frac{\alpha_i\left(\sigma-1\right)}{\theta-1}\left(-1 + \frac{\rho_0}{\eta_0 \Gamma_0}\right)$$

$$\frac{\partial \Gamma}{\partial r_i} = \frac{\alpha\left(\sigma-1\right)}{\theta-1}\frac{\partial \Gamma}{\partial r_i} - \Gamma_0 \frac{u}{1+u}\frac{\alpha_i\left(\sigma-1\right)}{\theta-1}$$

$$\frac{\partial \Gamma}{\partial r_i} = -\frac{\alpha_i}{\alpha}\Gamma_0 \frac{u}{1+u}\left(\Theta - 1\right)$$

$$\frac{\partial \Gamma}{\partial r_i}\frac{1}{\Gamma_0} = -\frac{u}{1+u}\frac{\alpha_i}{\alpha}\left(\Theta - 1\right)$$

Next with respect to η_i:

$$\frac{\partial \Gamma}{\partial \eta_i} = \frac{\partial}{\partial \eta_i}\frac{\pi(z^l)}{\bar{\pi}} + \Gamma_0 \frac{u}{1+u}\frac{\partial}{\partial \eta_i}\frac{\pi(z^h)}{\pi(z^l)}$$

$$\frac{\pi(z^l)}{\bar{\pi}} = \Gamma^{\frac{\alpha(\sigma-1)}{\theta-1}} \Pi_{i=1}^M \left[\frac{1-\psi_i}{\rho_i^l} - \frac{\psi_i \left(r_i - 1\right)}{\eta_i \Gamma}\right]^{\frac{\alpha_i(\sigma-1)}{\theta-1}}$$

$$\frac{\partial}{\partial \eta_i}\frac{\pi(z^l)}{\bar{\pi}} = \frac{\alpha(\sigma-1)}{\theta-1}\frac{\partial \Gamma}{\partial \eta_i}$$

$$\frac{\pi(z^h)}{\pi(z^l)} = \Pi_{i\in M}\left[\left(\frac{(r_i-1)\,\rho_i^l}{(1-\psi_i)\,\eta_i\Gamma - \psi_i\,(r_i-1)\,\rho_i^l}+1\right)\frac{1}{r_i}\right]^{\frac{\alpha_i(\sigma-1)}{\theta-1}}$$

$$\frac{\partial}{\partial r_i}\frac{\pi(z^h)}{\pi(z^l)} = 0$$

$$\frac{\partial \Gamma}{\partial \eta_i} = \frac{\alpha(\sigma-1)}{\theta-1}\frac{\partial \Gamma}{\partial \eta_i} = 0$$

Thus,

$$\begin{aligned}\ln n_i^{*u} \approx \ln n_{i0}^{*t} + \frac{1}{s_0^*}\ln\left(\frac{\eta_i}{\eta_0}\right) \quad &- \quad \frac{(1-s_0^*)}{s_0^*}\left[\ln\left(\frac{\rho_i^l}{\rho_0}\right)+\ln\left(\frac{\rho_i^h}{\rho_i^l}\right)\frac{u}{1+u}\right] \\ &- \quad \frac{(\Theta-1)}{s_0^*}\sum_{j\in M}\frac{\alpha_j}{\alpha}\left[\ln\left(\frac{\rho_j^l}{\rho_0}\right)+\ln\left(\frac{\rho_j^h}{\rho_j^l}\right)\frac{u}{1+u}\right]\end{aligned}$$

This is equation (26) in the main text.

Import values

$$m_i^u = s_i^*\alpha_i\,(\sigma-1)\,\pi^l$$

where $s_i^* = \frac{n_i^*\tau_i^{1-\theta}}{n_i+n_i^*\tau_i^{1-\theta}} = \frac{n_i^*}{\left(n_i^0\frac{B^*}{B}\right)\rho_i^l+n_i^*}$

$$\ln m_i^u = \ln\alpha_i\,(\sigma-1) + \ln s_i^* + \ln\frac{\pi^l}{\bar{\pi}} + \ln\bar{\pi}$$

$$\begin{aligned}\ln m_i^u \quad \approx \quad & \ln\alpha_i\,(\sigma-1) + \ln s_0^* + \ln\pi_0 + \frac{\partial s_i^*}{\partial n_i^*}\frac{n_i^*}{s_i^*}\ln\frac{n_i^{*u}}{n_{i0}^{*u}} + \frac{\partial s_i^*}{\partial \rho_i^l}\frac{\rho_i^l}{s_i^*}\ln\frac{\rho_i^l}{\rho_0} \\ & + \sum\left[\frac{\partial\frac{\pi^l}{\bar{\pi}}}{\partial\rho_i^l}\frac{\rho_i^l}{\Gamma_0}\ln\frac{\rho_i^l}{\rho_0} + \frac{\partial\frac{\pi^l}{\bar{\pi}}}{\partial r_i}\frac{1}{\Gamma_0}\ln r_i + \frac{\partial\frac{\pi^l}{\bar{\pi}}}{\partial\eta_i}\frac{\eta_0}{\Gamma_0}\ln\frac{\eta_i}{\eta_0}\right]\end{aligned}$$

$$\frac{\partial s_i^*}{\partial n_i^*}\frac{n_i^*}{s_i^*} = \frac{\left(n_i^0\frac{B^*}{B}\right)\rho_i^l}{\left(n_i^0\frac{B^*}{B}\right)\rho_i^l+n_i^*} = 1-s_i^*$$

$$\frac{\partial s_i^*}{\partial \rho_i^l}\frac{\rho_i^l}{s_i^*} = \frac{-\left(n_i^0 \frac{B^*}{B}\right)\rho_i^l}{\left(n_i^0 \frac{B^*}{B}\right)\rho_i^l + n_i^*} = -\left(1 - s_i^*\right)$$

$$\frac{\partial}{\partial \rho_i^l}\frac{\pi(z^l)}{\bar{\pi}} = -\frac{\alpha_i}{\alpha}\frac{\Gamma_0}{\rho_0}\left(\Theta - 1\right)$$

$$\frac{\partial}{\partial r_i}\frac{\pi(z^l)}{\bar{\pi}} = -\left(1 - \frac{s_0^*}{\Theta}\right)\frac{\alpha_i}{\alpha}\Gamma_0\frac{u}{1+u}\left(\Theta - 1\right)$$

$$\frac{\partial}{\partial \eta_i}\frac{\pi(z^l)}{\bar{\pi}} = 0$$

$$\begin{aligned}\ln m_i^u &\approx \ln \alpha_i\left(\sigma - 1\right) + \ln s_0^* + \ln \pi_0 + \left(1 - s_0^*\right)\ln \frac{n_i^{*u}}{n_{i0}^{*u}} - \left(1 - s_0^*\right)\ln \frac{\rho_i^l}{\rho_0} \\ &\quad -\frac{\alpha_i}{\alpha}\left(\Theta - 1\right)\sum\left[\ln \frac{\rho_i^l}{\rho_0} + \left(1 - \frac{s_0^*}{\Theta}\right)\frac{u}{1+u}\ln\left(\frac{\rho_j^h}{\rho_j^l}\right)\right]\end{aligned}$$

$$\begin{aligned}\ln m_i^u &\approx \ln\left[s_0^*\alpha_i\left(\sigma - 1\right)\ln \pi_0\right] + \frac{\left(1 - s_0^*\right)}{s_0^*}\ln\left(\frac{\eta_i}{\eta_0}\right) - \frac{\left(1 - s_0^*\right)}{s_0^*}\left[\ln\left(\frac{\rho_i^l}{\rho_0}\right) + \left(1 - s_0^*\right)\ln\left(\frac{\rho_i^h}{\rho_i^l}\right)\frac{u}{1+u}\right] \\ &\quad -\frac{\left(\Theta - 1\right)}{s_0^*}\sum_{j\in M}\frac{\alpha_j}{\alpha}\left[\ln\left(\frac{\rho_j^l}{\rho_0}\right) + \left(1 - \frac{s_0^{*2}}{\Theta}\right)\ln\left(\frac{\rho_j^h}{\rho_j^l}\right)\frac{u}{1+u}\right]\end{aligned}$$

This is equation (27) in the main text.

Finally, letting Δ_i denote the left-hand side (23),

$$\ln \Delta_i = \ln\left\{\rho_i^l + \frac{u\pi(z^h)}{\pi(z^l) + u\pi(z^h)}\left(1 - \frac{1}{r_i}\right)\right\} \geq 0$$

$$\frac{\partial \ln \Delta_i}{\partial \ln \rho_i^l} = 1$$

$$\frac{\partial \ln \Delta_i}{\partial \ln r_i} = \frac{u}{1+u}\frac{1}{\rho_0}$$

$$\ln \Delta_i \approx \ln \frac{\rho_i^l}{\rho_0} + \frac{u}{1+u}\frac{1}{\rho_0}\ln\left(\frac{\rho_i^h}{\rho_i^l}\right) \geq 0$$

which is equation (28) in the main text.

Table 1a. Summary Statistics of Product Level Variables by Pre-WTO Uncertainty in 2000

	Uncertainty(2000)		Total
	Low[a]	High[a]	
Chinese import value growth(Δln)[b]	1.13	1.33	1.20
	[1.71]	[1.65]	[1.69]
Chinese import variety growth(Δln)[b]	0.26	0.45	0.32
	[0.51]	[0.55]	[0.52]
Change in MFN tariff (Δln)	-0.06	-0.10	-0.07
	[0.07]	[0.08]	[0.08]
Uncertainty (2000)	0.03	0.14	0.07
	[0.04]	[0.04]	[0.06]
	3,177	1,584	4,761

Notes: All growth rates and changes between 2006-2000.

a. High refers to the top tercile of sample of pre-WTO uncertainty; Low otherwise.

b. Test of mean difference across samples significant at least at 1% level.

Table 1b. Summary Statistics of Variables in Main Regressions

	N	Mean	SD
A. Product-country level value (Table 2)			
Imports(ln)	569,806	11.12	3.49
Uncertainty-Pre[a]	140,868	0.07	0.06
Uncertainty-Post[b]	428,938	0.13	0.09
Tariff(ln)-Pre	140,868	0.14	0.08
Tariff(ln)-Post	428,938	0.09	0.06
Uncertainty-Pre(max[c])	140,868	0.18	0.14
Uncertainty-Post(max)	428,938	0.24	0.16
B. Firm-product level intermediates (Tables 3, 5 & 9)			
Imports(ln)	4,591,741	7.80	2.96
Variety(ln)	4,591,741	0.21	0.45
Uncertainty-Pre	943,757	0.06	0.05
Uncertainty-Post	3,647,984	0.11	0.07
Tariff(ln)-Pre	943,757	0.12	0.06
Tariff(ln)-Post	3,647,984	0.08	0.04
C. Firm-product level value/variety (Tables 4 & 7)			
Imports(ln)	7,572,273	9.03	2.94
Variety(ln)	7,572,273	0.19	0.43
Uncertainty-Pre	1,590,380	0.06	0.05
Uncertainty-Post	5,981,893	0.12	0.07
Tariff(ln)-Pre	1,590,380	0.13	0.06
Tariff(ln)-Post	5,981,893	0.08	0.05
Uncertainty-Pre(max)	1,590,380	0.15	0.12
Uncertainty-Post(max)	5,981,893	0.21	0.14

Notes: a. Pre refers to pre-WTO period (2000-2001).
b. Post refers to post-WTO period (2002-2006).
c. max means threat tariff = historical max during the period 1992-1999, used in robustness checks in Table 9.

Table 2: Product-country-year Level Import Value, Intermediates

Dependent Variable = Imports (ln)

	1	2	3	4
Uncertainty			-10.34***	-7.798***
			[0.755]	[0.665]
Uncertainty×Post			5.894***	4.627***
			[0.801]	[0.699]
Tariffs (ln)	-5.103***	-3.585***	-3.408***	-3.011***
	[0.392]	[0.380]	[0.405]	[0.387]
Tariffs(ln)×Post	-5.986***	-5.063***	-5.766***	-5.134***
	[0.562]	[0.537]	[0.562]	[0.551]
Fixed Effects	ct	ct+s	ct	ct+s
N	371,285	371,285	371,285	371,285
R^2	0.131	0.165	0.145	0.171

Notes: Dependent variable imports (ln) are Chinese import values defined at the hs6-country-year level. Tariffs (ln) are 1 plus the Chinese statutory MFN tariff rates at the hs6-year level. Uncertainty is measured as ln (τ_{mean}/τ_t), where τ_{mean} is (1 plus) Chinese average MFN tariff rate during the pre-WTO period 1992-1999, and τ_t is (1 plus) Chinese MFN tariff rate in current year. Post is a post-WTO dummy that is equal to 1 for years since 2002, and 0 otherwise.Standard errors clustered at the hs6-year level in parenthesis, with *, **, and *** denote, respectively, significance at 0.10, 0.05, and 0.01. For fixed effects, c denotes country, s denotes section, and t denotes time (year).

Table 3: Firm-product-year Level Import Value - Intermediates

Dependent Variable = Imports(ln)

	1	2	3	4
Uncertainty			-7.970***	-7.903***
			[0.515]	[0.522]
Uncertainty×Post			4.558***	4.531***
			[0.567]	[0.577]
Tariffs (ln)	-3.656***	-3.581***	-2.512***	-2.365***
	[0.464]	[0.457]	[0.441]	[0.437]
Tariffs(ln)×Post	-2.119***	-2.320***	-3.208***	-3.481***
	[0.588]	[0.578]	[0.581]	[0.563]
Fixed Effects	f+t+s	ft+s	f+t+s	ft+s
N	4,680,193	4,591,741	4,680,193	4,591,741
R^2	0.287	0.33	0.293	0.336

Notes: Dependent variable imports (ln) are Chinese import values defined at the firm-hs6-year level. Tariffs (ln) are 1 plus the Chinese statutory MFN tariff rates at the hs6-year level. Uncertainty is measured as ln (τ_{mean}/τ_t), where τ_{mean} is (1 plus) Chinese average MFN tariff rate during the pre-WTO period 1992-1999, and τ_t is (1 plus) Chinese MFN tariff rate in current year. Post is a post-WTO dummy that is equal to 1 for years since 2002, and 0 otherwise.Standard errors clustered at the hs6-year level in parenthesis, with *, **, and *** denote, respectively, significance at 0.10, 0.05, and 0.01. For fixed effects, f denotes firm, s denotes section, and t denotes time (year).

Table 4: Firm-product-year Level Import Value - All Products

Dependent Variable = Imports(ln)

	1	2	3	4
Uncertainty			-9.108***	-8.904***
			[0.435]	[0.429]
Uncertainty×Post			5.807***	5.706***
			[0.470]	[0.468]
Tariffs (ln)	-2.456***	-2.472***	-0.805**	-0.824**
	[0.366]	[0.360]	[0.395]	[0.390]
Tariffs(ln)×Post	-2.040***	-2.125***	-4.717***	-4.763***
	[0.480]	[0.476]	[0.527]	[0.515]
Fixed Effects	f+t+s	ft+s	f+t+s	ft+s
N	7,531,534	7,435,142	7,531,534	7,435,142
R^2	0.27	0.314	0.277	0.321

Notes: Dependent variable imports (ln) are Chinese import values defined at the firm-hs6-year level. Tariffs (ln) are 1 plus the Chinese statutory MFN tariff rates at the hs6-year level. Uncertainty is measured as ln (τ_{mean}/τ_t), where τ_{mean} is (1 plus) Chinese average MFN tariff rate during the pre-WTO period 1992-1999, and τ_t is (1 plus) Chinese MFN tariff rate in current year. Post is a post-WTO dummy that is equal to 1 for years since 2002, and 0 otherwise.Standard errors clustered at the hs6-year level in parenthesis, with *, **, and *** denote, respectively, significance at 0.10, 0.05, and 0.01. For fixed effects, f denotes firm, s denotes section, and t denotes time (year).

Table 5: Firm-product-year Level Import Varieties

Dependent Variable = Number of Imported Varieties(ln)

	All Firms			
	Intermediates		All Products	
	1	2	3	4
Uncertainty	-0.137**	-0.144**	-0.134**	-0.136**
	[0.0626]	[0.0694]	[0.0520]	[0.0567]
Uncertainty×Post	0.169**	0.179**	0.169***	0.169***
	[0.0746]	[0.0831]	[0.0569]	[0.0630]
Tariffs (ln)	-0.192***	-0.195***	-0.328***	-0.345***
	[0.0504]	[0.0544]	[0.0469]	[0.0483]
Tariffs(ln)×Post	-0.320***	-0.343***	-0.325***	-0.334***
	[0.0746]	[0.0795]	[0.0606]	[0.0623]
Fixed Effects	f+t+s	ft+s	f+t+s	ft+s
N	4,680,193	4,591,741	7,531,534	7,435,142
R^2	0.178	0.21	0.166	0.193

Notes: Dependent variable (ln) number of imported varieties by firm defined at the hs8-country-year level. Tariffs (ln) are 1 plus the Chinese statutory MFN tariff rates at the hs6-year level. Uncertainty is measured as ln (τ_{mean}/τ_t), where τ_{mean} is (1 plus) Chinese average MFN tariff rate during the pre-WTO period 1992-1999, and τ_t is (1 plus) Chinese MFN tariff rate in current year. Post is a post-WTO dummy that is equal to 1 for years since 2002, and 0 otherwise.Standard errors clustered at the hs6-year level in parenthesis, with *, **, and *** denote, respectively, significance at 0.10, 0.05, and 0.01. For fixed effects, f denotes firm, s denotes section, and t denotes time (year).

Table 6: Firm-product-year Level Import Value - Robustness to Firm and Product Group Characteristics

Dependent Variable = Imports(ln)

	Baseline	Production Firms	
	Intermediates	All Products	Intermediates
	1	2	3
Uncertainty	-7.903***	-8.462***	-6.188***
	[0.522]	[0.526]	[0.511]
Uncertainty×Post	4.531***	5.622***	3.389***
	[0.577]	[0.588]	[0.585]
Tariffs (ln)	-2.365***	-0.813*	-1.575***
	[0.437]	[0.459]	[0.437]
Tariffs(ln)×Post	-3.481***	-4.346***	-3.330***
	[0.563]	[0.645]	[0.567]
Fixed Effects	ft+s	ft+s	ft+s
N	4,591,741	2,615,800	1,685,399
R^2	0.336	0.284	0.286

Notes: Dependent variable imports (ln) are Chinese import values defined at the firm-hs6-year level. Tariffs (ln) are 1 plus the Chinese statutory MFN tariff rates at the hs6-year level. Uncertainty is measured as ln (τ_{mean}/τ_t), where τ_{mean} is (1 plus) Chinese average MFN tariff rate during the pre-WTO period 1992-1999, and τ_t is (1 plus) Chinese MFN tariff rate in current year. Post is a post-WTO dummy that is equal to 1 for years since 2002, and 0 otherwise.Standard errors clustered at the hs6-year level in parenthesis, with *, **, and *** denote, respectively, significance at 0.10, 0.05, and 0.01. For fixed effects, f denotes firm, s denotes section, and t denotes time (year).

Table 7: Firm-product-year Level Import Value - All Products by Export Status

	Dependent Variable = Imports(ln)					
	Never Exporters		Always Exporters		New Exporters	
	1	2	3	4	5	6
Uncertainty	-5.903***	-5.525***	-10.03***	-9.929***	-8.850***	-8.116***
	[0.389]	[0.392]	[0.472]	[0.468]	[0.529]	[0.500]
Uncertainty×Post	4.079***	3.634***	6.015***	6.096***	6.299***	5.580***
	[0.431]	[0.438]	[0.501]	[0.503]	[0.578]	[0.557]
Tariffs (ln)	-0.741**	-0.752**	-0.479	-0.475	-1.210**	-1.039**
	[0.347]	[0.371]	[0.431]	[0.422]	[0.496]	[0.487]
Tariffs(ln)×Post	-3.323***	-3.361***	-5.423***	-5.457***	-4.273***	-4.385***
	[0.476]	[0.495]	[0.552]	[0.540]	[0.652]	[0.638]
Fixed Effects	f+t+s	ft+s	f+t+s	ft+s	f+t+s	ft+s
N	881,227	850,963	2,599,746	2,589,769	497,887	491,860
R^2	0.446	0.486	0.217	0.257	0.285	0.34

Notes: Dependent variable imports (ln) are Chinese import values defined at the firm-hs6-year level. Subsamples defined based on firm export status from 2000-2006: never, always, and new exporters. Tariffs (ln) are 1 plus the Chinese statutory MFN tariff rates at the hs6-year level. Uncertainty is measured as ln (τ_{mean}/τ_t), where τ_{mean} is (1 plus) Chinese average MFN tariff rate during the pre-WTO period 1992-1999, and τ_t is (1 plus) Chinese MFN tariff rate in current year. Post is a post-WTO dummy that is equal to 1 for years since 2002, and 0 otherwise.Standard errors clustered at the hs6-year level in parenthesis, with *, **, and *** denote, respectively, significance at 0.10, 0.05, and 0.01. For fixed effects, f denotes firm, s denotes section, and t denotes time (year).

Table 8: Firm-product-year Level Import Value - SOE and non-SOE Firm Samples

Dependent Variable = Imports(ln)

	State Owned		Non-State Owned	
	1	2	3	4
Uncertainty	-13.30***	-11.64***	-11.50***	-8.460***
	[0.602]	[0.627]	[0.541]	[0.487]
Uncertainty×Post	8.626***	7.091***	8.440***	5.852***
	[0.659]	[0.683]	[0.602]	[0.541]
Tariffs (ln)	-1.196**	-0.865*	-3.092***	-2.083***
	[0.561]	[0.503]	[0.499]	[0.404]
Tariffs(ln)×Post	-5.489***	-5.232***	-6.855***	-5.087***
	[0.687]	[0.626]	[0.669]	[0.562]
Fixed Effects	ft	ft+st	ft	ft+st
N	1,927,349	1,927,349	5,507,793	5,507,793
R^2	0.238	0.27	0.308	0.339

Notes: Dependent variable imports (ln) are Chinese import values defined at the firm-hs6-year level. Subsamples defined based on firm export status from 2000-2006: never, always, and new exporters. Tariffs (ln) are 1 plus the Chinese statutory MFN tariff rates at the hs6-year level. Uncertainty is measured as ln (τ_{mean}/τ_t), where τ_{mean} is (1 plus) Chinese average MFN tariff rate during the pre-WTO period 1992-1999, and τ_t is (1 plus) Chinese MFN tariff rate in current year. Post is a post-WTO dummy that is equal to 1 for years since 2002, and 0 otherwise.Standard errors clustered at the hs6-year level in parenthesis, with *, **, and *** denote, respectively, significance at 0.10, 0.05, and 0.01. For fixed effects, f denotes firm, s denotes section, and t denotes time (year).

Table 9: Firm-product-year Level Import Value Robustness to Alternative Threat Measure - Intermediates

Dependent Variable = imports(ln)

	Baseline	Alternative Measure
Tariff Threat:	Historical Avg	Historical Max
	1	2
Uncertainty	-7.903***	-3.628***
	[0.522]	[0.213]
Uncertainty×Post	4.531***	1.273***
	[0.577]	[0.244]
Tariffs (ln)	-2.365***	-1.581***
	[0.437]	[0.451]
Tariffs(ln)×Post	-3.481***	-2.997***
	[0.563]	[0.573]
Fixed Effects	ft+s	ft+s
N	4,591,741	4,591,741
R^2	0.336	0.338

Notes: Dependent variable imports (ln) are Chinese import values defined at the firm-hs6-year level. Subsamples defined based on firm export status from 2000-2006: never, always, and new exporters. Tariffs (ln) are 1 plus the Chinese statutory MFN tariff rates at the hs6-year level. Uncertainty is measured in columns 2-3 as ln (τ_{max}/τ_t), where τ_{max} is (1 plus) Chinese maximim MFN tariff rate during the pre-WTO period 1992-1999, and τ_t is (1 plus) Chinese MFN tariff rate in current year. Post is a post-WTO dummy that is equal to 1 for years since 2002, and 0 otherwise.Standard errors clustered at the hs6-year level in parenthesis, with *, **, and *** denote, respectively, significance at 0.10, 0.05, and 0.01. For fixed effects, f denotes firm, s denotes section, and t denotes time (year).