Firm Input Choice Under Trade Policy Uncertainty*

By Kyle Handley[†], Nuno Limão[‡], Rodney D. Ludema[§] and Zhi Yu[¶]

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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 requires a sunk cost investment, then the prospect of price increases in that input, e.g. due to trade barriers, reduces the adoption of that input (a substitution effect) and possibly other inputs (complementarity via lower profits). Thus trade policy uncertainty can affect a firm's entire input mix. We provide a new model of input price uncertainty that captures both effects and derive its empirical implications. We test these using an important episode that lowered input price uncertainty: China's accession to the WTO and the associated commitment to bind its import tariffs. We estimate large increases in the value and adoption of imported inputs by firms from accession; the reduced uncertainty from commitment generates substitution effects larger than the reductions in applied tariffs in 2000-2006 and has significant profit effects.

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[†]University of Michigan and NBER. Email: handleyk@umich.edu

[‡]University of Maryland and NBER. Email: limao@umd.edu

[§]Georgetown University. Email: ludemar@georgetown.edu

[¶]Renmin University of China. Email: yuzhi@rmbs.ruc.edu.cn

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 decisions to adopt them depend on how uncertain their prices are. One such source of uncertainty is future policy, e.g. taxes on domestic or imported inputs, that affects 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 ongoing 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 (Crowley et al., 2018; Feng et al., 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.[1] 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 commit-

[1] Uncertainty can also affect exports via inventory effects (Alessandria et al, 2019).

ment effects. Research on the effect of TPU provides support for the idea that a country's exporters benefit from agreements that tie the foreign governments hands. We provide theory and 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 et al., 2016; Yu, 2015) and reductions in U.S. TPU that Chinese exporters faced in the U.S. (Feng et al., 2017; Handley and Limão, 2017; Pierce and Schott, 2016). Both of these channels are potentially important for Chinese export outcomes.[2] 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.[3] We focus 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 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, which gives rise to input complementarity in our setting.

We use transactions-level trade data from 2000-2006 to examine how China's WTO tariff commitments affected its firm's imports of intermediates. After its economic reform and opening in the late 1970s, China applied to re-enter the GATT in 1986 and then its successor, the WTO, which it acceded in 2001. As we show in Figure 1 the average statutory import tariff was over 40% when it applied and around 10% by 2006. Most research on the WTO impact focuses on the tariff reductions after 2000, but this is only about one third of the import liberalization that occurs since 1992 (Lardy, 2002). The process since 1992 was driven

[2] Amiti, et. al. (2018) find that both lower Chinese input tariffs and US TPU contributed to the reduction in their export prices to the US.

[3] Gervais (2018) models and tests an alternative channel whereby more risk averse managers source from lower price volatility input suppliers.

by the “Socialist Market Economy” reforms and arguably as a condition for WTO accession (cf. Tang and Wei, 2009). A similar pattern holds for intermediate products as we see since 1992. The outcome of this accession process was uncertain until 2001; and if China had not joined then it could have reversed some of the earlier liberalization.[4] 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. We first provide descriptive evidence that (i) at least 2/3 of that import growth is from new HS-6 products, (ii) the fraction of importing firms increases, and (iii) there are sunk costs at the variety level. We then test the model predictions by constructing the required measure of tariff risk for imported inputs in each HS-6 category, which is the difference between the historical mean tariff dating back to 1992 and its respective current rate. The regression analysis, which controls for applied tariff changes and various fixed effects, shows that this tariff risk depressed Chinese firms' imported intermediates prior to WTO entry, and that this effect is sharply reduced after WTO entry, consistent with increased commitment.[5]

We find evidence consistent with several additional aspects of the model. First, the applied tariff trade elasticity increases substantially after WTO entry, suggesting that importers perceived them to be more permanent. Second, we identify both substitution and complementarity effects. Third, the estimates vary with initial firm productivity. Finally, we find that post-accession firms, were more likely to adopt products that were previously subject to higher risk.

There are important quantitative implications from these estimates. The probability of reversal falls substantially—it is predicted to be less than 13 percent after accession. In 2000-2006 real intermediate import values increased on average 141 log points (lp) in the data; we estimate WTO accession accounts for at least 84 lp. Commitment effects reflect substitution effects—which are larger than those of applied tariffs—and complementarity effects; the latter are about 28 lp and are an upper bound for the impact on firm profits.

We provide the theory in section 2; the data and empirical strategy in section 3; the estimates, robustness and preliminary quantification in 4; and conclude in section 5. Derivation and estimation details are in the appendices.

[4] Several events contributed to this uncertainty including the death of Deng Xiaoping in 1997 (who promoted the "Socialist Market" reforms), the 1996 Taiwan Strait Crisis, the 1999 U.S. bombing of the Chinese embassy in Serbia and the 2001 midair collision of a U.S. spy plane and Chinese fighter jet.

[5] These results are robust to alternative firm samples, risk measures, sources of TPU and explanations such as history dependence.

2 Model

We consider a dynamic model of heterogeneous firms producing a differentiated final product from a primary factor (labor) and a continuum of intermediate inputs. Any firm present in the market in period t survives into $t+1$ with probability β, which is the only discount factor for future profits. Firms enter and exit the market at a constant rate, such that their mass is constant.

In each period, the firm observes the prevailing input prices and makes three joint decisions: (a) how many varieties of each intermediate input to adopt; (b) how much to spend on each input, including labor; (c) the price of the final good. To keep the last two decisions simple, we assume functional forms such that expenditure shares and markups over marginal cost are constant.

Inputs are indexed by $i \in [0,1]$ and each i is available in a continuum of varieties on $\mathbf{R}_+$. For each firm f and input i, we partition varieties into three disjoint intervals depending on whether they require a sunk cost of adoption and are exposed to price risk. These intervals are shown in Figure 2. The first, $[0, \bar{n}_i]$, consists of **safe varieties:** those with no sunk cost and a fixed price normalized to one. The second, $\left(\bar{n}_i, \bar{n}_i + \mu_{if}\right]$, consists of **exposed varieties**: those with no sunk cost but a time-varying relative price, τ_i^t, which follows a Markov process. The third, $\left(\bar{n}_i + \mu_{if}, \infty\right)$, consists of **risky varieties**: those with sunk cost $K > 0$ and the same time-varying relative price as exposed varieties. The last interval is our primary focus, as the combination of sunk cost and price risk distort the firm's choice of which (if any) varieties from this type to adopt.[6] The parameter μ_{if} governs the prevalence of this distortion, which we allow to be both firm- and input-specific. If $\mu_{if} = 0$, all variable price varieties are risky, whereas if μ_{if} is large, risk becomes irrelevant.

In light of our empirical application to a setting of trade policy uncertainty, we label $[0, \bar{n}_i]$ as domestic varieties and $(\bar{n}_i, \infty)$ as imported varieties, of which $\left(\bar{n}_i + \mu_{if}, \infty\right)$ are risky. We interpret τ_i^t the tariff-inclusive relative price of imported varieties. Our objective is to capture large permanent regime shifts in a tractable way. We follow Handley and Limão (2017) and model a three-state Markov process with an initial state tariff vector $\boldsymbol{\tau}^l$ and a constant probability γ that this policy changes the following period to a new vector $\boldsymbol{\tau}^s$ drawn with probability ϖ^s. We assume the following for tractability. First, there are only three states with tariffs ranked as follows $\boldsymbol{\tau}^h > \boldsymbol{\tau}^l > \boldsymbol{\tau}^g$. Second, the extreme cases are absorbing (so there is only uncertainty in the initial intermediate state).

To simplify the presentation we first develop our results assuming $\varpi^g = 0$ so there are

[6] There is a fourth possible configuration of sunk costs and price uncertainty, namely, those varieties with a fixed price and $K > 0$. We rule this case out, as it contributes very little to our analysis of imports under policy uncertainty.

effectively only two relevant cases and γ is the probability that the government increases protection. We then show that the results extend to allowing for a more favorable state, $\varpi^g > 0$, and γ is more easily interpreted as a measure of policy uncertainty. The equivalence between these two approaches is explained by the "bad news principle" (Bernanke, 1983): when firms can wait and see before making investments then only the expected severity of bad news matters.

2.1 Preferences, Technology and Current Profits

A firm is characterized by a productivity parameter φ_f drawn from a common distribution $F(\varphi)$ and a set of parameters μ_{if} drawn for each input independently from a common distribution $G(\mu)$, both with non-negative support. For now we assume $G(\mu)$ is absolutely continuous but relax this assumption in section 4.3.4. The parameters are drawn on entry and remain constant for the life of the firm. In what follows, we consider the problem facing a generic firm and thus drop the firm subscript for notational convenience.

The 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 aggregate 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 intermediate inputs, according to,

$$\ln y = \ln \varphi + (1-\alpha)\ln l + \alpha \int_0^1 \ln(x_i)\, di \tag{2}$$

where l is labor input and x_i is the quantity of intermediate input i, and $\alpha < 1$ is the cost share of intermediates. Each input is composed of a continuum of varieties aggregated with constant elasticity of substitution $\theta > 1$:

$$x_i = \left[\int_0^{n_i} x_i(\nu)^{\frac{\theta-1}{\theta}} d\nu\right]^{\frac{\theta}{\theta-1}} \tag{3}$$

where n_i is the measure of varieties (extensive margin) chosen.

If the current relative price of imported varieties of input i is τ_i, then a firm would have a current cost index for input i of $z_i^{\frac{1}{1-\theta}}$, where

$$z_i\left(n_i,\tau_i\right)=\begin{cases}\bar{n}_i+\left(n_i-\bar{n}_i\right)\tau_i^{1-\theta} & \text{if } n_i>\bar{n}_i\\ n_i & \text{if } n_i\leq\bar{n}_i\end{cases}\tag{4}$$

Since the unit cost index is decreasing in z_i the firm can lower it by expanding the extensive margin. Therefore at the very least the firm adopts all varieties that carry no sunk adoption cost, and hence we can confine our attention to $n_i \geq \bar{n}_i + \mu_i$.

Aggregating over all inputs and normalizing $w = 1$, the log unit cost of the final good is,

$$\ln c=\ln\tilde{\alpha}-\ln\varphi+\frac{\alpha}{1-\theta}\int_0^1\ln\left(z_i\right)di\tag{5}$$

where $\tilde{\alpha}\equiv\alpha^{-\alpha}\left(1-\alpha\right)^{\alpha-1}$.

The profit-maximizing price of the final good is $\hat{p}=\frac{\sigma}{(\sigma-1)}c$. Thus, the one-period log operating profit of a firm can be written as,

$$\ln\left[\pi(z)\right]=\ln A+(\sigma-1)\ln\varphi+\frac{\alpha\left(\sigma-1\right)}{\theta-1}\int_0^1\ln\left(z_i\right)di\tag{6}$$

where $A\equiv E\sigma^{-\sigma}(\sigma-1)^{\sigma-1}\left(\tilde{\alpha}\right)^{1-\sigma}$.

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

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

We show in the appendix that $\pi(z)$ is strictly concave if $\frac{\alpha(\sigma-1)}{\theta-1}<1$. This is satisfied if the elasticity of substitution between two varieties of the same input is greater than that between two different final goods, i.e., $\theta>\sigma$, which we assume henceforth. Furthermore, differentiation of (7) yields $\pi_{z_iz_j}(z)>0$ for all $i\neq j$, and thus $\pi(z)$ is supermodular.[7]

2.2 Input Choice under Certainty

Before considering the problem with uncertainty, we solve the benchmark with certainty, i.e., $\gamma=0$, or equivalently, $\tau_i^l=\tau_i^h=\tau_i$ for all i. The firm chooses each n_i to maximize the expected present value of profits net of adoption costs,

[7] By itself, Cobb-Douglas technology would imply that inputs are neither gross complements nor gross substitutes. Thus the supermodularity property, which gives rise to input complementarity in our model, is driven by a profit effect alone. This is reflected in its dependence on the final demand elasticity.

$$V(z) = \frac{\pi(z)}{1-\beta} - K \cdot \int_0^1 [n_i - (\bar{n}_i + \mu_i)]\, di \tag{8}$$

with $n_i \geq \bar{n}_i + \mu_i$.

The first-order condition compares the marginal operating profit from increasing z_i with the marginal cost of adding an imported variety with sunk cost K,

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

with strict equality for an interior solution, i.e., $n_i > \bar{n}_i + \mu_i$.[8]

Solving (9) for the optimal extensive margin of *imports*, $n_i^* \equiv n_i - \bar{n}_i$, gives $n_i^* = \max\{\tilde{\mu}_i, \mu_i\}$, where

$$\tilde{\mu}_i \equiv \kappa\pi - \rho_i \tag{10}$$

and $\rho_i \equiv \bar{n}_i\tau_i^{\theta-1}$ and $\kappa \equiv \frac{\alpha(\sigma-1)}{(\theta-1)(1-\beta)K}$. If the measure of exposed varieties μ_i is sufficiently high, then the firm does not pay to adopt risky ones as well. Otherwise it does and in that case the extensive margin of imports is increasing in operating profit, decreasing in own input tariff and on sunk cost.

Using this we solve for import expenditure for each input. Given CES at the variety level, the share of imports in total spending on input i is,

$$s_i^* = \frac{n_i^*}{\rho_i + n_i^*} \tag{11}$$

Domestic plus import expenditure on i is $\alpha(\sigma-1)\pi$, which follows from the Cobb-Douglas input technology (see appendix). Thus import spending is,

$$m_i^* = \alpha(\sigma-1)\pi\frac{n_i^*}{\rho_i + n_i^*}, \tag{12}$$

which increases with operating profit and declines with own tariff, via ρ_i. Using the optimal n_i^*, this expression becomes,

$$m_i^* = \alpha(\sigma-1)\begin{cases} \frac{\tilde{\mu}_i}{\kappa} & \text{if } \tilde{\mu}_i \geq \mu_i \\ \pi\frac{\mu_i}{\rho_i+\mu_i} & \text{if } \tilde{\mu}_i < \mu_i \end{cases} \tag{13}$$

When it is optimal to adopt risky varieties, $\tilde{\mu}_i \geq \mu_i$, then $n_i^* = \tilde{\mu}_i$ and the import value across i is fully determined by the extensive margin of imports. Otherwise, $n_i^* = \mu_i$ so

[8] We abstract from sunk costs to start producing or importing. They are not necessary or sufficient to generate the impact of product specific risk on imports that we subsequently find. However, such costs could be incorporated in the theory.

import values vary across i due to both the extensive margin, via the exogenous variable, μ_i, and the intensive margin, via ρ_i.

To determine operating profit, we substitute (10) into (4) yielding, $z_i = \tau_i^{1-\theta} \cdot \max(\kappa\pi, \rho_i + \mu)$ and use this in (6) to obtain

$$\ln \pi = \Theta \left[\ln \left(A\varphi^{\sigma-1} \right) + \frac{\alpha(\sigma-1)}{\theta-1} \int_0^1 \left(\ln \left(\tau_i^{1-\theta} \right) + G(\tilde{\mu}_i) \ln(\kappa) + \int_{\tilde{\mu}_i}^{\infty} \ln(\rho_i + \mu) \, dG \right) di \right], \tag{14}$$

where $\Theta \equiv \left[1 - \frac{\alpha(\sigma-1)}{\theta-1} \int_0^1 G(\tilde{\mu}_i) \, di \right]^{-1} > 1$ is a multiplier, reflecting the fact that the exogenous profit shifters in brackets induce changes in imported input intensity, which further affect profits. This multiplier is an increasing function of the average probability of sunk-cost variety adoption across all inputs, $G(\tilde{\mu}_i)$, which itself depends on π; hence (14) is an implicit profit function.

We obtain comparative statics for operating profit by totally differentiating (14) (holding A and κ fixed) and using Leibnitz's integral rule to obtain,

$$\begin{aligned} d \ln \pi = {} & \Theta \left[(\sigma-1) \, d \ln \varphi + \frac{\alpha(\sigma-1)}{\theta-1} \int_0^1 \delta_i \left(d \ln \bar{n}_i \right) di \right] \\ & - \alpha(\sigma-1) \Theta \int_0^1 (1-\delta_i) \left(d \ln \tau_i \right) di \end{aligned} \tag{15}$$

where $\delta_i \equiv \int_{\tilde{\mu}_i}^{\infty} \frac{\rho_i}{\rho_i+\mu} dG < 1$ and $\frac{\rho_i}{\rho_i+\mu_i}$ measures the domestic spending share for inputs where risky varieties are not adopted ($\mu_i > \tilde{\mu}_i$). Thus, operating profit is increasing in productivity and the aggregate number of available domestic varieties and decreasing in the aggregate tariff. The tariff elasticity on the second line captures how they lower profit proportionally to their share of intermediate inputs in total cost $\alpha(1-\delta_i)$, the elasticity of profit with respect to cost $\sigma - 1$, and the multiplier effect Θ.

2.3 Input Choice under Uncertainty

We now introduce uncertainty. The vector of relative import prices for all i is τ^l in the initial period and there is a constant probability γ of it increasing to $\tau^h \geq \tau^l$ in the following period and remaining there indefinitely. Uncertainty is therefore characterized by how likely the current regime is to change, γ common across all inputs, and if so by how much in each i; to distinguish between these we refer to τ_i^h/τ_i^l as policy risk (e.g. tariff risk).

The present discounted value of a firm starting at τ^l is defined recursively by,

$$\Pi \left[z \left(n, \tau^l \right) \right] = \pi \left[z \left(n, \tau^l \right) \right] + \beta (1-\gamma) \Pi \left[z \left(n, \tau^l \right) \right] + \beta\gamma \frac{\pi \left[z \left(n, \tau^h \right) \right]}{1-\beta} \tag{16}$$

where $\beta(1-\gamma)$ and $\beta\gamma$ are the probabilities that the firm survives and faces the low-tariff and high-tariff states, respectively, in the next period. Note that if the firm adopts n varieties under τ^l then it optimally continues to use them under τ^h. After tariffs increase the firm does not gain from decreasing n because any adoption costs were already sunk, and it would not wish to increase n because of the supermodularity of π.

To simplify notation, let $z^s = z(n, \tau^s)$ for $s = l, h$. After solving (16), total profits can be written as,

$$V(z^l, z^h) = \frac{\pi(z^l)}{(1-\beta)} U\left(z^l, z^h\right) - K \cdot \int_0^1 (n_i^* - \mu_i)\, di \tag{17}$$

where $U\left(z^l, z^h\right) \equiv \frac{1+u\left[\pi(z^h)/\pi(z^l)\right]}{(1+u)} < 1$ and $u \equiv \frac{\beta\gamma}{(1-\beta)}$. So U scales down discounted profits at current input prices due to the probability they will increase, alternatively: it is the ratio of discounted profits under uncertainty relative to certainty. The firm wishes to maximize (16) subject to $n_i^* \geq \mu_i$.

Again the first-order condition compares the marginal operating profit from expanding the extensive margin with the marginal cost of adding an imported variety, yielding:

$$\frac{\pi_{z_i}^l \cdot \left(\tau_i^l\right)^{1-\theta} + u\pi_{z_i}^h \cdot \left(\tau_i^h\right)^{1-\theta}}{(1+u)(1-\beta)} \leq K \tag{18}$$

with strict equality for $n_i > \bar{n}_i^*$. Solving (18) for the optimal extensive margin of imports gives, $n_i^{*u} = \max\left\{\tilde{\mu}_i^u, \mu_i\right\}$, where

$$\tilde{\mu}_i^u \equiv (1-\psi_i)\,\kappa\pi(z^l)U - \psi_i\left(\rho_i^h - \rho_i^l\right) - \rho_i^l \tag{19}$$

and $\psi_i \in \left[0, \frac{1}{2}\right]$. In the limit case where $\gamma = 0$ or $\tau^l = \tau^h$ we have $\psi_i = 0$ and $U = 1$ so this reduces to the condition under certainty in (10).[9] Similarly to the certainty condition if μ_i is sufficiently high, then the firm does not pay to adopt risky ones as well. Otherwise, it adopts risky varieties and their number increases in operating profit and decreases with the current tariff, as was the case under certainty. Under uncertainty three additional elements affect imported varieties in the interior case. First, profits are reduced by U, which reflects the probability of moving to the high-tariff state. Second, the gap $\rho_i^h - \rho_i^l$ enters negatively, even though the high tariff does not currently apply. Third, the elements of the expression are weighted by ψ_i, which reflects the uncertainty specific to input i. This weight is equal to zero under certainty and up to one half otherwise.

[9] In particular, $\psi_i = \frac{1}{2} - \frac{1}{2}\left[1 - \frac{u}{1+u}\frac{4\kappa\pi(z^h)\left(\rho_i^h - \rho_i^l\right)}{\left[\kappa\pi(z^l)U + \left(\rho_i^h - \rho_i^l\right)\right]^2}\right]^{1/2}$, which is zero when $\rho_i^h = \rho_i^l$ or $u = 0$ and can be no larger than 1/2, which occurs when the square root term is zero.

These three additional elements suggest that the firm is more conservative about expanding its extensive margin under uncertainty than if it faces a certain τ^l, which we establish in the following lemma.

Lemma 1: *The optimal extensive margin of imported varieties, n_i^*, is (weakly) lower under uncertainty than under certainty for all i, as is the probability of the firm adopting risky imports, $G(\tilde{\mu}_i)$, and the operating profit in the low-tariff state, $\pi(z^l)$.*

Proof in Appendix.

We build on this lemma to prove the result for import values below. So it is useful to provide some intuition. Since the cost of expanding the extensive margin is sunk, the firm chooses that margin in the low-tariff state taking into account it will keep it in an eventual high cost state as well. Thus, it will generally choose an extensive margin under uncertainty that differs from its optimal choice under certainty: n_i^{*u} is lower than n_i^* under τ^l and higher than n_i^* under τ^h.

The distortion of the extensive margin under uncertainty has implications for the firm's import expenditure in the low-tariff state as well. Import expenditure on input i is given by,

$$m_i^{*u} = \alpha\,(\sigma-1)\,\pi(z^l)\frac{n_i^{*u}}{\rho_i + n_i^{*u}} \tag{20}$$

Using the optimal n_i^{*u}, this expression becomes,

$$m_i^{*u} = \alpha\,(\sigma-1)\begin{cases} \left(\frac{\tilde{\mu}_i^u}{\kappa}\right)\frac{\pi(z^l)}{(1-\psi_i)\kappa\pi(z^l)U-\psi_i\left(\rho_i^h-\rho_i^l\right)} & \text{if } \tilde{\mu}_i^u \geq \mu_i \\ \pi(z^l)\frac{\mu_i}{\rho_i^l+\mu_i} & \text{if } \tilde{\mu}_i^u < \mu_i \end{cases} \tag{21}$$

The effect of uncertainty on import value follows from Lemma 1 above.

Proposition 1: *For each input i, each firm's import expenditure is (weakly) lower under uncertainty than under certainty.*

Proof in Appendix.

In addition to having a level effect, uncertainty implies that the value of imports for $\tilde{\mu}_i^u \geq \mu_i$ is no longer a fixed proportion of the extensive margin. Rather, there is an additional term $\frac{\pi(z^l)}{(1-\psi_i)\pi(z^l)U-\psi_i\left(\eta_i^h-\eta_i^l\right)} > 1$ reflecting a positive effect of uncertainty on the intensive margin in the low-tariff state. Intuitively, the firm adjusts the intensive margin to partially compensate for the distorted extensive margin in each state: increasing it in the low state and decreasing it in the high state. Thus the intensive margin adjustment mitigates the effect of uncertainty on import spending. For inputs where risky varieties are not adopted the import spending function in (20) is the same as (13), except that the value of operating profits is generally lower under uncertainty.

2.4 Three State Extension

Thus far we assumed that after a policy change the only possible state is the one with higher tariffs, h. We now argue that the possibility of a more favorable state does not affect our results and provides an option value of waiting interpretation. The equivalence between these two approaches is explained by the "bad news principle" (Bernanke, 1983): when firms can wait and see before making investments then only the expected severity of bad news matters. Thus, the effect of trade policy uncertainty on input decisions is not driven by the expected value of future τ *per se* but only by the expected value of the less favorable state.

We demonstrate this principle applies to our multi-dimensional decision problem in Appendix A.6. Specifically, we show the first order condition is still given by (18) but $u' = u(1-\varpi) < u$ where $1-\varpi$ is the probability of the worst state h conditional on a policy change. Here we make two observations. First, this extension does not affect the estimation, only the interpretation of the variable we construct, which becomes a measure of tail risk. Second, this extension allows us to identify two distinct impacts of changes in γ: a long-run mean effect and a pure risk effect. We are interested in the combined impact of changes in the uncertainty parameter, γ, and the tail risk measure we compute is sufficient to capture it.[10]

2.5 Approximation

In this section, we take a step towards estimation. We re-introduce f subscripts to clarify the level of variation of alternative variables. As the draws of μ_{if} are unobservable (to the econometrician), we characterize the expected value of $\ln(m_i^u)$ over the distribution $G(\mu)$. Moreover, as this expression is non-linear, it is useful to work with a first-order Taylor approximation of $E_\mu \ln(m_i^u)$ around a specific point $(\tau_0, \bar{n}_0, \varphi_0)$ for all f and i where E_μ denotes the expectation over the distribution of μ. This allows us to estimate the approximate effects of deviations from this point in all three dimensions. The approximation of $E_\mu \ln(m_i^u)$ (derived in the appendix) is,

[10] As Handley and Limão (2015) show if a given initial policy τ^l is at its long-run mean then any increases in γ imply a mean-preserving spread of that policy, i.e. a pure risk effect. If τ^l is below that long-run mean then higher γ increases it, otherwise it decreases it.

$$E_\mu \ln\left(m_{if}^{*u}\right) \approx \Phi^m + \Phi_f^m + \Phi_i^m - (\theta-1)\left[(\delta_0+\xi_0)\ln\left(\frac{\tau_i^l}{\tau_0}\right) + (1-\tilde{s}_0^*)\,\xi_0\frac{u}{1+u}\ln\left(\frac{\tau_i^h}{\tau_i^l}\right)\right]$$
$$- \alpha(\sigma-1)\,\Theta_0(1-\delta_0)(1+\xi_0)\left(\int_0^1 \ln\left(\frac{\tau_i^l}{\tau_0}\right)dj\right)$$
$$- \alpha(\sigma-1)\left[\Theta_0(1-\delta_0)(1+\xi_0) - E_\mu(s_0^*)\right]\left(\frac{u}{1+u}\int_0^1 \ln\left(\frac{\tau_j^h}{\tau_j^l}\right)dj\right) \tag{22}$$

where $\tilde{s}_0^*$ is the import share of a firm that adopts risky imports (i.e., $n_i^{*u} > \mu$) and $\xi_0 \equiv \rho_0 G(\tilde{\mu}_0)/\tilde{\mu}_0$.

The first three terms are a constant Φ^m, a firm effect Φ_f^m, and an input effect Φ_i^m.[11] The remaining terms on the top line capture the substitution effects of the current tariff τ_i^l and tariff risk, $\ln\left(\frac{\tau_i^h}{\tau_i^l}\right)$, which enter negatively. The second and third line capture the profit effects of the average tariff and average tariff risk, respectively. They too enter negatively.[12] This is because the tariff on each input negatively affects profits, thus indirectly lowering imported input use across all inputs. This effect depends on the profit elasticity with respect to average tariffs, $\alpha(\sigma-1)\,\Theta_0(1-\delta_0)$, as in equation (15).

All of the tariff and TPU effects in (22) depend on ξ_0, which is proportional to the probability that the firm adopts sunk-cost varieties, $G(\tilde{\mu}_0)$. Consider what would happen if the firm were so unproductive as to have $G(\tilde{\mu}_0) = 0$ (this would occur if φ_0 were so low that $\tilde{\mu}_0 = \kappa\pi_0 - \rho_0 < 0$). In case, the only imported varieties would be riskless (i.e., no sunk cost). As such varieties would be imported regardless of tariffs, the extensive margin of each input would be invariant to tariffs and to tariff risk. The value of imports of such varieties will continue to be affected by tariffs (via the intensive margin) but not by tariff risk.[13] Thus, for the case of a low productivity firm for which $G(\tilde{\mu}_0) = 0$, (22) becomes,

$$E_\mu \ln\left(m_{if}^{*u}\right) \approx \Phi^m + \Phi_f^m + \Phi_i^m - (\theta-1)\,\delta_0 \ln\left(\frac{\tau_i^l}{\tau_0}\right)$$
$$- \alpha(\sigma-1)(1-\delta_0)\left(\int_0^1 \ln\left(\frac{\tau_j^l}{\tau_0}\right)dj\right). \tag{23}$$

[11] Specifically, $\Phi^m + \Phi_f^m + \Phi_i^m = E_\mu \ln m_0^* + (1+\xi_0)\,\delta_0\Theta\frac{\alpha(\sigma-1)}{\theta-1}\int_0^1 \ln\left(\frac{\bar{n}_i}{\bar{n}_0}\right)di + (1+\xi_0)\,\Theta(\sigma-1)\ln\left(\frac{\varphi}{\varphi_0}\right) - (\xi_0+\delta_0)\ln\left(\frac{\bar{n}_i}{\bar{n}_0}\right)$.

[12] It is not obvious, but $\Theta(1-\delta_0)(1+\xi_0) - E(s_0^*) \geq 0$. This follows from $E(s_0^*) = 1-\delta_0 - G(1-\tilde{s}_0^*)$, which implies $(\Theta(1+\xi_0)-1)(1-\delta_0) + G(1-\tilde{s}_0^*) \geq 0$, as $\Theta \geq 1$.

[13] While the tariff and TPU elasticities are zero for sufficiently low productivity, they need not be monotonically increasing in φ_0 for $G(\tilde{\mu}_0) > 0$. While $\tilde{\mu}_0$ increases with productivity, the derivative of ξ_0 with respect to $\tilde{\mu}_0$ depends on the shape of G.

In this case, imports are affected by current tariffs but not TPU and in fact imports are the same for this firm as under certainty. This is because TPU only distorts choices of risky varieties and the low productivity firm does not to adopt any.

In addition to the value of imports at the firm level, we wish to estimate the impacts of tariff risk on other firm outcomes, such as the cost of production and current operating profits. Since the latter is proportional to the former, we provide the approximation of its expected log value:

$$\begin{aligned} E_{\mu} \ln \pi(z^{l}) \approx\ & \Phi^{\pi} + \Phi^{\pi}_{f} + \Phi^{\pi}_{i} - \alpha\left(\sigma - 1\right)\Theta_{0}\left(1 - \delta_{0}\right)\left(\int_{0}^{1} \ln \tau^{l}_{i} di\right) \\ & - \alpha\left(\sigma - 1\right)\left[\Theta_{0}\left(1 - \delta_{0}\right) - E_{\mu}\left(s^{*}_{0}\right)\right]\frac{u}{1+u}\left(\int_{0}^{1} \ln\left(\frac{\tau^{h}_{i}}{\tau^{l}_{i}}\right) di\right). \end{aligned} \tag{24}$$

The elasticities of average tariffs and tariff risk are smaller than in (22) due to absence of $1 + \xi_0 > 1$.[14]

3 Estimation Approach and Data

We describe the econometric specifications implied by the model for firm-specific input import values. We then describe the data and provide descriptive statistics.

3.1 Approach

We use variation in applied tariffs, τ^{l}_{i}, and risk, $\tau^{h}_{i}/\tau^{l}_{i}$, across inputs for each firm. We allow these variables to have different elasticities before and after WTO accession to capture any change in the probability of tariff increases and test if the resulting effects are consistent with the model. We describe the steps and identification assumptions necessary to obtain our baseline estimation equations that focus on the own tariff or substitution effects and control for profit effects by using firm-time fixed effects. Subsequently, we provide the conditions to identify the profit effects.

The relative price of the imported intermediate in the initial period in the theory is τ^{l}_{i}, which we assume varies only due to trade barriers. In the data, the true relative price, τ^{l}_{it}, varies over time even in the low tariff state and has determinants beyond tariffs. Therefore we rely on a parsimonious empirical model where its key determinant is the applied import

[14] This is because average tariffs and average tariff risk affect imports in two ways, as can be seen in (20): first by affecting $\pi(z^{l})U$, which affects the extensive margin, and second by affecting $\pi(z^{l})$, which affects the intensive margin. Equation (24) involves only the second of these effects.

tariff factor in category i at time t denoted by $\bar{\tau}_{it} \geq 1$ and control for other determinants as follows

$$\ln \tau^{l}_{it} = \ln \bar{\tau}_{it} + \delta_t + e^{\delta}_{it}, \tag{25}$$

where the time effect, δ_t, controls for aggregate shocks, e.g. to exchange rates, and e^{δ}_{it} is i.i.d. random noise.

The relevant threat barrier driving firm decisions depends on their belief of the protection level to which the Chinese government may revert. We do not observe this belief directly but both we and those firms do observe historical tariffs, τ^{h}_{i}. So we model true firm beliefs, $\ln \tau^{h}_{it}$, as a weighted average of the observable $\ln \tau^{h}_{i}$ and an average tariff equivalent $\ln \tau$, common across products and unobservable to us. Thus we have

$$\ln \tau^{h}_{it} = h \ln \tau^{h}_{i} + (1-h) \ln \tau + e^{h}_{it}, \tag{26}$$

where the weight $h \in [0, 1]$ is reflected in the estimation coefficients and e^{h}_{it} is an idiosyncratic shock with mean zero and orthogonal to τ^{h}_{i} and τ^{l}_{it}.[15]

Allowing the applied tariffs to vary over time in the approximation (22) and using the empirical models in (25) and (26), we derive the specification for import values as

$$\ln m_{ift} = \beta^{m}_{\tau t} \ln \bar{\tau}_{it} + \beta^{m}_{ht} \ln \frac{\tau^{h}_{i}}{\bar{\tau}_{it}} + \mathbf{a}_{f,t,I} + e_{ift}. \tag{27}$$

The current ad valorem tariff factor $\bar{\tau}_{it}$ and the threat tariff τ^{h}_{i} are observed. The error term e_{ift} includes idiosyncratic firm-product-time shocks (including errors from approximation and the empirical models of relative price and beliefs). Initially we do not include the aggregate policy effects on a firm explicitly but fully account for them using a set of firm-time effects, $\mathbf{a}_{ft}$. In order to identify those aggregate effects we subsequently include only firm and time effects, $\mathbf{a}_{f}$ and $\mathbf{a}_{t}$, respectively.[16]

The coefficients on applied tariffs, $\beta^{m}_{\tau t}$ are predicted to be negative. Moreover, both these and β^{m}_{ht} are potentially time-varying through γ_t. If 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 $\beta^{m}_{ht} < 0$.

We model WTO accession using an indicator variable for the post-period, i.e. $\mathbf{1}_{wto}(t > 2001)$, to test whether there is an uncertainty shock $\Delta\gamma = \gamma_{wto} - \gamma_{pre} \neq 0$. This approach

[15] Broda et al (2008) show the tariffs measured by τ^{h}_{i} are increasing in Chinese import market power so an alternative interpretation is that firms believed that the government is more likely to exploit import market power if a WTO accession does not materialize.

[16] We control for potential variation in domestic varieties, captured in Φ^{m}_{i} approximation terms, via industry effects $\mathbf{a}_{I}$ at different levels of aggregation I, described in the estimation and robustness.

yields the baseline specification

$$\ln m_{ift} = \left(\beta^m_{\tau,pre} + \Delta\beta^m_\tau \cdot \mathbf{1}_{wto}\right) \ln \bar{\tau}_{it} + \left(\beta^m_{h,pre} + \Delta\beta^m_h \cdot \mathbf{1}_{wto}\right) \ln \frac{\tau^h_i}{\bar{\tau}_{it}} + \mathbf{a}_{f,t,I} + e_{ift}. \tag{28}$$

As noted above, in the pre-WTO period $\beta^m_{h,pre} < 0$ when $\gamma_{pre} > 0$ and $h > 0$; and applied tariffs have a negative effect, $\beta^m_{\tau,pre} < 0$. The theory predicts that if there is a reduction in uncertainty then $\Delta\beta^m_h = \beta^m_{h,wto} - \beta^m_{h,pre} > 0$ when $h > 0$. The theory also predicts an increase in the responsiveness to applied tariffs estimated by $\Delta\beta^m_\tau = \beta^m_{\tau,wto} - \beta^m_{\tau,pre} < 0$ for beliefs with $h < 1$, i.e. if firms place some weight on threats other than the historical mean τ^h_i (shown below).

The structural interpretation is

$$\beta^m_{ht} = -(\theta - 1)(1 - \tilde{s}^*_0)\,\xi_0 \frac{u_t}{1+u_t} h \tag{29}$$

$$\beta^m_{\tau,t} = -\left[(\theta - 1)(\delta_0 + \xi_0) + \frac{1-h}{h}\beta^m_{ht}\right]. \tag{30}$$

Using these interpretations we calculate the percentage change in TPU upon accession

$$\Delta\left(\frac{u}{1+u}\right) / \left(\frac{u_{pre}}{1+u_{pre}}\right) = \Delta\beta^m_{ht}/\beta^m_{hpre}. \tag{31}$$

Note that if $h < 1$ then $\beta^m_{\tau,t}$ also changes over time with uncertainty, specifically, $\Delta\beta^m_\tau = -\frac{1-h}{h}\Delta\beta^m_{ht}$.[17] So we can infer the belief parameter h, using

$$h = \frac{\Delta\beta^m_h}{\Delta\beta^m_h - \Delta\beta^m_\tau}. \tag{32}$$

We can test if it is within the relevant range $h \in [0, 1]$, whether it is similar across alternative specifications and how relevant alternative threat measures are for beliefs. If $h < 1$ then $\beta^m_{\tau,t}$ reflects its value under certainty, $\beta^m_{\tau,t}|_{\beta^m_{ht}=0} = -(\theta-1)(\delta_0+\xi_0)$, attenuated by the fraction of the uncertainty effect that is not controlled, $\frac{1-h}{h}\beta^m_{ht}$.

3.2 Data

We combine Chinese trade data from 2000-2006 with product specific tariffs from before and after WTO accession.

[17] To see why note that if $h = 1$ then conditional on the risk measure $\frac{\tau^h_i}{\bar{\tau}_{it}}$, the applied tariff elasticity is constant and given by $-(\theta-1)(\delta_0+\xi_0)$, but otherwise the elasticity is attenuated because there is a probability of reversion to the threat component we do not observe, τ.

3.2.1 Firm Imports

We use Chinese transaction-level trade data for the years 2000 to 2006, which is collected by China's General Administration of Customs. The data records information on each transaction including the Chinese firm's name, code, contact information, ownership; the product code (at 8-digit); the country of the counterpart (source of import or destination of export); year and month; value; and trade type (ordinary or processing). We use imports and concord the product codes to be in the 1996 version of the Harmonized System 6-digit product classification (known as HS6) using the official UN concordances. We identify intermediate products using the UN's Broad Economic Categories.

We focus on ordinary imports and exclude processing trade. Ordinary imports refer to non-processing imports and are subject to Chinese import tariffs and thus are a closer fit to our model and policy data. Processing trade imports on the other hand receive tariff exemptions and may be affected by other policies and incentives that we can't control for and may be correlated with the policy uncertainty we measure, hence we exclude those imports.[18]

Our analysis focuses on firm import values, which is the best available variable that directly maps to the theory. However, we also explore the mechanism of the model by using indicators for whether a firm adopted a specific HS-6 and examining how it changes.

3.2.2 Tariffs

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).[19] We use the historical tariffs before 2000 to construct Chinese tariff risk measures, which will be proportional to the log 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.

[18]The two most important types of processing trade are: (1) processing with imports (PWI) and (2) processing with assembly (PWA). 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.

[19]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.

3.3 Descriptive Evidence

3.3.1 Policy

We measure the tariff risk faced by Chinese firms using $\ln\left(\tau_i^h/\bar{\tau}_{it}\right)$. In the baseline we use the simple log average of the tariff factor between 1992-1999 in i for $\ln\tau_i^h$ and the applied tariff in t for $\bar{\tau}_{it}$. In the pre-WTO years tariff risk has a mean of 0.07 for intermediate products and a standard deviation of 0.05, so it exhibits considerable variation (see Table 1). There is also considerable variation within the typical sector (defined by the UN's aggregation of HS-6 codes into 21 sections, as shown in Table A3). This will allow us to control for unobservable heterogeneity across sectors. The applied tariff factor, $\ln\bar{\tau}_{it}$, is around 0.12 for intermediates in our firm sample before accession and 0.075 after. The coefficient of variation is between 0.4 and 0.5 across periods and is present in several sectors as seen in Table A2.[20]

3.3.2 Aggregate and Intermediate Imports

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

Chinese imports increased from 225 billion USD in 2000 to 788 billion USD in 2006. Ordinary imports (OI) increased from 133 to 469 billion, mostly after accession as we see in Figure 3. While the share of OI is roughly constant, around 60%, its composition shifted towards intermediates—the focus of our theory. Figure 3 shows the intermediate share of OI increased from an average of 66% in 2000-2001 to 70% in 2005-2006. This also implied an increase in the OI intermediates share of total imports. In contrast, the share of processing trade remained around 40%.

There are also changes in the composition of importing firms away from state-owned enterprises and trade intermediaries (Table A1).[21] These may reflect an increase in the incentive to import by private manufacturing firms consistent with the model. However, they also reflect the continued opening of trade rights to non-SOEs and small-to-medium sized manufacturing firms. We will show the baseline results are robust to excluding SOEs and using subsets of firms that already imported pre-accession so the effects are not driven by changes in trade rights.

[20] After the WTO accession our risk measure increases because the measured threat is assumed to be unchanged but the applied tariff falls.

[21] 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", "trade", etc., then it is classified as a trade intermediary.

3.3.3 Firm Import Adoption and Persistence

A substantial fraction of the aggregate intermediate growth is driven by new input adoption. To provide a lower bound we can define a continuing input, $i \in c$, between t and T as an HS6 product the firm imports in both periods and decompose its intermediate import expenditure midpoint growth between these and all other products.

$$\frac{\Delta m_{i,f}}{\bar{m}_{i,f}} = \underbrace{\left[(1 - s_c) \cdot \frac{\Delta m_{i \notin c,f}}{\bar{m}_{i \notin c,f}}\right]}_{\text{New HS6}} + \underbrace{s_c \cdot \frac{\Delta m_{i \in c,f}}{\bar{m}_{i \in c,f}}}_{\text{Continuing HS6}}, \tag{33}$$

where the denominators reflect averages over the periods, e.g. $\bar{m}_{i,f} = (m_{i,f,t} + m_{i,f,T})/2$, and thus allow computing growth if there is entry or exit.

Doing so for 2000-2005 for continuing firms and others we obtain

$$\begin{aligned} 1.01 &= (\underbrace{[0.28 \cdot 0.75]}_{\text{New HS6: continuing firms}} + 0.72 \cdot 0.77) \cdot 0.6 + \underbrace{[1.37] \cdot 0.4}_{\text{New HS6: other}} \\ &= \underbrace{0.67}_{\text{New HS6 Growth: all}} + 0.33, \end{aligned} \tag{34}$$

The aggregate midpoint growth of 101 percent reflects the values in table A1 between 2000-2005. The term in () in the first line is the import growth of continuing firms: 21 percent new HS6 and 55 for continuing HS6. All of the the 137 percent growth by other firms captures new adoption (at some point between 2001-2005). Weighting the 21 and 137 percent by the firms' respective shares yields 67 percent, so at least two thirds of aggregate growth is accounted for by new HS6-firm pairs. This is a lower bound since varieties may be defined more finely so they also contribute to part of the 55 percent growth in continuer firms's existing HS6 (e.g. imports from new countries and/or firms in an HS6).

Table A4 summarizes information on the probability of importing, the distribution of imported HS6 by firms and their change over time. In 2000 about 11% of all manufacturing firms imported at least one intermediate HS6. About 14% of these imported a single intermediate HS6, which suggests that sunk (or fixed) costs are variety or at the very least product specific, otherwise if they covered all imports then firms would adopt all available HS6 (relevant for its production) after incurring it. Our estimation approach relies on the remaining fraction of firms, those with more than one HS6 in order to explore variation in risk across HS6 within firms. The number of importing firms nearly doubles by 2005 and the fraction of importers of intermediates in manufacturing rises to 13%. There is growth in all bins with the largest at the bottom of the distribution, 10 or fewer, which further supports the role of new adoption.[22]

[22] The product distribution of importers in 2006 is similar to 2005.

In Table A5 we provide additional summary statistics aggregating the years into pre or post periods and contrasting the full sample with continuing firms. The table contains information for the full sample and the manufacturing subsample and we discuss the latter for comparability with the rest of this section. In the pre-period the mean number of intermediate HS6 per importing manufacturing firm was 13—much higher than the median of 4 (panel I). The coefficient of variation of 1.8 shows considerable heterogeneity in input usage across firms—as the model would predict.[23] The mean of adopted HS6 is similar in the pre and post-period in panel I since there is more adoption growth at the lower end of the distribution in this sample that includes both continuing and other firms (as seen in Table A4). The composition effect is driven by new firms, which tend to adopt fewer varieties.[24] In panel II we see that for continuing importers in 2000-2005 the mean, median and maximum grow. The mean growth in HS6 used in 2000-2005 for continuers is 8.6 lp.

The small fraction of importing firms confirms the existence of some adoption costs. If these were simply fixed costs then there would be no input hysteresis and so any input used at t would depend only on current firm and input conditions. Alternatively, and as the model requires, if costs are sunk then prior input usage should predict current usage *even after controlling for all firm and input current conditions.* To test if there is evidence for such sunk costs we run the following linear probability model

$$1(m_{ift} > 0) = \beta^{sunk} 1(m_{ift-1} > 0) + \mathbf{a}_{ft} + \mathbf{a}_{i,t} + e_{ift}, \tag{35}$$

where $\mathbf{a}_{ft} + \mathbf{a}_{i,t}$ represent firm and product effects interacted with time. In Table A6 we see β^{sunk} is around 0.15 and significant at the 1 percent level with minor variations depending on the sample (all and manufacturing firm subsample) and set of fixed effects (sector or HS6 or their interactions with time). This further supports the existence of some firm-variety sunk costs.

4 Estimation

We first provide the baseline regression results for import values and robustness. We follow with evidence on the mechanism of the model that explores firm heterogeneity and adoption. We conclude with a quantification using the econometric estimates to assess the relative

[23] This heterogeneity can also be due to time-invariant sectoral variation, which we control for in the regressions. We will also see there is variation in adoption even within firms in the same industry and consistently with the model it varies by initial productivity.

[24] We can verify this by computing the average number of varieties for continuing importers in 2000-2005 relative to the overall sample, which is higher by 1.4 times in 2000 and 1.54 in 2005.

importance of applied tariffs versus commitment on imported inputs due to accession.

4.1 Baseline: Imported Intermediate Values

We now provide regression evidence for the role of TPU in firm-level imports. We focus on ordinary import values of intermediates, which are best suited to test the model. In the robustness section we provide estimates for alternative samples.

The estimates in Table 2 apply the baseline model in (28) to firm-level import values. In columns 1 and 2, we include only the applied tariff and post-WTO accession interaction; we control for sector and alternative firm fixed effects. The tariff elasticity is negative as expected and it increases in magnitude in the post-WTO period. In columns 3 and 4 we add tariff risk and see that it reduces the value of import intermediates pre-WTO, a key prediction of the model and this is partially reversed post-WTO, as shown in the positive and significant differential effects. Magnitudes are nearly the same for both sets of fixed effects: firm (column 1 and 3) and firm-time (2 and 4), where the latter controls for the profit effect on the composite bundle of all the firm inputs.[25]

While we did not restrict the parameters of the estimation, we obtain estimates of two structural parameters in the relevant range. Specifically, in column 4 we obtain the proportionate change in $u/(1+u)$ of -0.51; and $h = 0.49$, so importers believed the historical average captured half the threat.

4.2 Robustness

We check the robustness of the baseline with respect to alternative firm and product samples and risk measures. We also test if alternative hypotheses regarding other sources of TPU and history dependence affect the results.

4.2.1 Firm sample

The firm information in the trade transactions data does not allow us to perfectly distinguish between importers that are manufacturing 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 issue, we restricted our trade transactions sample to those that can be matched to firms in the Chinese manufacturing census. Table 3 reports the baseline for all intermediate goods trade in column 1. This can be compared to column 3, the manufacturing firm subsample. We continue to find a negative uncertainty effect in the pre-WTO period that is partially

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

reversed following accession. The tariff elasticity also increases after accession, as in our baseline. The sign and significance patterns are the same in the manufacturing subsample and the differences in coefficient magnitudes relative to the baseline are not large enough to generate quantitatively different conclusions; the implied uncertainty reduction is -0.51 in both.

4.2.2 Composition and trading rights effects

One possible explanation for the change in tariff elasticity post-WTO is composition of firm imports and/or new rules that allowed more firms to import. In the model we assume the input elasticity θ is common across all i, but if newly adopted inputs, or entering firms, had systematically higher elasticity then it would be reflected in higher post-WTO estimates. To test this we re-estimate using a panel that includes only firm-HS6 cells with positive imports in at least one year in the pre and post-WTO period. Doing so yields very similar coefficients as seen by comparing the estimates in column 2 of Table 3 to those in column 1. The fact that the result holds even if we restrict the sample to firm-HS6 that already imported in the pre-WTO period also indicates that the baseline estimates are not driven by new firms acquiring trade rights post-WTO accession.

4.2.3 State ownership

Next we check if there is heterogeneity in our results depend on whether a firm is State Owned Enterprise (SOE). In Table 4 we re-estimate the baseline for the SOE subsample (column 2), which account for about one quarter of observations in the baseline, and the non-SOE (column 4). The qualitative results are present in both samples and they reflect similar proportionate changes in u.

4.2.4 Correlated shocks and alternative sources of TPU

We have focused on TPU related to imported inputs, but existing theories and evidence for TPU point to investments by firms to increase their *exports*. We consider two variations of these existing export theories and ask if they can explain our findings of increased imports. We first consider the "home export TPU" mechanism: more secure access to foreign markets leads home firms to expand, and therefore adopt more inputs including imported ones. If the input adoption is common across all HS-6 then they are captured by the firm-time effects and do not affect our results; the same will be true if they are uncorrelated with changes in foreign market TPU. However, our results could be affected if there is a positive correlation between import and export shocks at the product level, e.g. if firm export and import bundles are concentrated in similar HS-6.[26] If this were the driving force for our findings then they should hold for exporting firms but not for firms that never export. We test this by dividing the sample into "Never Exporters", "Always Exporters", and "New Exporters" and running our baseline specification on these sub-samples in Table 5. For all three samples, we find negative uncertainty effects in the pre-WTO period that are partially and significantly reversed following accession. The implied change in u and h are identical.[27] So, while this alternative source of TPU can and has been shown to increase Chinese firm *exports*, it does not drive our import results.

The second variation is the "foreign export TPU" mechanism: more secure access to the home market leads foreign firms to increase varieties to it and be directly reflected as the higher home firm imports. A distinguishing feature of this export mechanism is that the foreign firm decision depends on the aggregate demand in the home market, whereas our import mechanism implies that even if a variety is available some home firms will adopt and others will not. If we had transaction-level data on all foreign firms exporting to China then we could fully control for this export mechanism. However, this data does not exist and so we consider alternative econometric approaches that try to maintain the available foreign variety bundles as constant as possible before and after accession so any import adoption reflects variation of importing firm behavior.

Here we define country-varieties as exporter-HS6 pairs. We exclude imports of new country-varieties by using only imports from ci pairs that were continuously exported to China in all periods. Doing so leaves the baseline coefficients largely unchanged as shown in Table 6 column 2 relative to column 1. We can apply a stricter criteria that excludes any ci unless they continuously sold to a specific production sector. This allows for the possibility that each of the over 400 production sectors classified in China source different varieties within any given ci. Doing so reduces the sample in column 4 to about one third of the relevant manufacturing sample in column 3 but does not change the estimated coefficients. In a subsequent section we control for *all* foreign export-TPU by including HS6-time effects and exploring firm productivity heterogeneity to identify the remaining import TPU effects.

[26] For example, WTO accession reduced TPU in the US and thus increased China's exports to that market. If the Chinese uncertainty measure across products is correlated with the one in the U.S. then our results may overstate the impact of the import mechanism.

[27] Specifically, u is -0.45 for always and -0.42 for never; h is 0.45 and 0.36 respectively. The absolute value of the elasticities are smaller for never exporters. This may be due to different composition of inputs or lower productivity. We examine variation regarding the latter in the mechanism section.

4.2.5 Alternative risk measure and history dependence

We examine how our results depend on the measurement of the threat tariff in Table 7. As an alternative to using the historical mean tariff by product for 1992-1999 (column 1), we use the historical maximum tariff (column 2), which is typically close to the 1992 value. 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 alternative 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 probability of reversal to the maximum is $h = 0.26$, about half the value of the probability of reversal to the mean measure in the baseline.[28]

Our main focus is on the change in the effects of tariffs after the WTO accession, which does not reflect any unobserved effects of a product that are constant over time. To interpret and quantify the pre-WTO effects as well we may want to test robustness to alternative hypotheses. One such hypothesis is that firms face sunk costs but no uncertainty; if that were the case then tariffs set at T affect the input technology firms adopt in that period and as long as the technology does not depreciate or is replaced. This is plausible for shorter periods but unlikely in our setting. For example, the historical maximum reflects tariffs around 1992 so the technology would have had to survive until 2000-2001 to explain what we find in Table 7. Many of the firms in our sample were not created until much later. The baseline results reflect the mean tariffs between 1992-1999 and thus the explanation seems a priori more plausible. Under this alternative, the relevant historical average should only reflect periods while the firm was alive, so the 1992-1999 average should have smaller explanatory power for firms created in the later periods. To test this we restrict the sample of manufacturing firms to those created after 1997 and re-run the specification in Table 3 column 3 (available on request). This restriction reduces the sample by more than half but leaves the coefficients largely unchanged in terms of magnitudes and standard errors. This identical response from younger firms indicates they place similar weight on tariffs they did not actually face and supports our uncertainty interpretation of the measure.

[28] Thus importers placed a lower probability on a reversal to the 1992 tariffs, which reflect the regime prior to the "Socialist Market Economy" reforms as indicated in Figure 1.

4.3 Mechanism Evidence

We now provide evidence on the mechanisms of the model, specifically on intermediates vs. consumption goods, productivity heterogeneity, complementarity and adoption effects.

4.3.1 Intermediates vs. Consumption Goods

Thus far we focused on the subset of HS6 that match the UN BEC intermediate classification. If we find the same quantitative effect for final consumption goods then it is harder to distinguish our mechanism from others, such as the export TPU. A simple way to test this is provided in Table 8 where we run the baseline on the sample of final consumption goods. For the sample including all firms (column 2) we find effects that are qualitatively similar to those for intermediates (replicated in column 1) but with considerably smaller elasticities. This may reflect the "export TPU" channel previously documented by other authors. Importantly, for the subsample that is most relevant for the theory—the manufacturing firms—we find no statistically significant evidence for the uncertainty channel in consumption goods (column 4). This provides additional evidence that the baseline results for inputs capture a mechanism distinct from the standard export TPU in the literature.[29]

4.3.2 Productivity Heterogeneity

We now examine how the import elasticities depend on initial firm productivity.

Our baseline approach used an approximation around a given firm productivity and product characteristics so firm heterogeneity was controlled via firm fixed effects. According to the theory, the risk elasticity of imports is proportional to $(1-\tilde{s})\,\xi$. If a firm is sufficiently unproductive so as not to adopt any risky imported inputs, this elasticity is zero. Thus, its import equation in (23) reflects no uncertainty impact. When a firm is sufficiently productive to adopt some intermediates then its risk elasticity relative to a more productive firm is ambiguous and depends on the properties of the exposed variety distribution G. Given this we ask if there is any significant difference in the uncertainty coefficients between high and low productivity. If there is then we explore it and ask if it is robust to controlling for the foreign export-TPU mechanism.

We use the matched manufacturing data to compute productivity for each firm present in the pre-WTO period. Productivity is measured as real output per worker to maximize

[29] Interestingly, we find some uncertainty effects for capital goods in both samples (available on request). Their magnitudes are closer to the intermediates but the estimates are much less precise. There are two possible reasons. First, the intermediate classification is subject to error, for example it may be too narrow and misclassify some HS6 as capital goods. Second, the basic insight of the model can be adapted for capital goods.

the number of observations. Firms are classified as high productivity (H) if in the pre-WTO period they are above their industry's median and low (L) otherwise. Column 1 of Table 9 confirms the baseline predictions hold for high productivity firms. This is also the case when we run the baseline for this subsample of low productivity in column 2. In column 3 we pool these subsamples and report the estimated coefficients for low on the left and the differential for high relative to low on the right. We find that the accession had a larger impact for high productivity firms reflected in the differential coefficients for risk and applied tariffs in the post period.

Column 4 offers further robustness of the results relative to foreign export TPU. Here we find that the magnitude and significance of high productivity differentials are robust to including HS6 by time effects (so we can only identify the differential between high and low). This robustness indicates that the differentials are driven by input TPU and not by foreign export TPU, since the HS6-time effects control for *any* change in the availability of foreign input varieties in China.

4.3.3 Profit and Input Complementarity Effects

Thus far we focused on own substitution effects: larger imports of an input i if it has lower relative price and risk. We now examine if there are complementarities across inputs, i.e. if reductions in the cost or risk in inputs $j \neq i$ increase imports of i.

To do so we augment the baseline estimation equation in (28) as follows

$$\begin{aligned}\ln m_{ift} &= \left(\beta^m_{\tau,pre} + \Delta\beta^m_\tau \cdot \mathbf{1}_{wto}\right)\ln\bar{\tau}_{it} + \left(\beta^m_{h,pre} + \Delta\beta^m_h \cdot \mathbf{1}_{wto}\right)\ln\frac{\tau^h_i}{\bar{\tau}_{it}} + \mathbf{a}_{f,t,I} + e_{ift} \quad (36)\\ &\quad + \Delta\bar{\beta}^m_\tau \cdot \mathbf{1}_{wto}\int_0^1 \ln\bar{\tau}_{jt}dj + \Delta\bar{\beta}^m_h \cdot \mathbf{1}_{wto}\int_0^1 \ln\left(\tau^h_j/\tau^l_j\right)dj.\end{aligned}$$

The two new terms are in the second line. To apply the approximation in (22) we need to compute a simple log average over relevant inputs, e.g. for risk we need $\int_0^1 \ln\left(\tau^h_j/\tau^l_j\right)dj$.[30] This measure and the applied tariff analog have no product variation and so are firm specific, which implies that we can't identify their baseline effect separately from the firm effect, $\mathbf{a}_f$, but we can still identify the differential post-WTO effect if we restrict the firm effect to be fixed over time, as we now will.

The sign predictions are the same as those for the respective substitution effects if γ falls: $\Delta\bar{\beta}^m_h > 0$ (if $h > 0$) and $\Delta\bar{\beta}^m_\tau < 0$ (if $h < 1$).[31] In Table 10 we implement this

[30] We use a firm's production sector to determine the full set of potential inputs it uses and avoid the endogeneity of computing averages over only the adopted set.

[31] Similarly, we can obtain structural predictions from (22) and the empirical models in (25) and (26). For

for the manufacturing sample. The first column replicates the baseline only including the substitution effects for comparison. The second column adds new variables. The substitution effects are unchanged and we find evidence for the complementarity impacts: the reduction in uncertainty in other inputs increased imports of i, $\Delta\bar{\beta}_h^m > 0$. Moreover, the magnitude of the elasticity of i's tariffs with respect to other inputs increased. The results are robust to a subsample of firms that import before and after the accession (column 3).

The last two columns split the sample into high and low productivity and as predicted we find larger profit effects for high, partially because the profit multiplier, Θ, increases with productivity.

4.3.4 Probability of Adoption

The baseline model assumes there are always some riskless imported varieties in a category i, and thus there are positive imports within each i with probability one. While this is likely to hold at a high enough level of aggregation, at the HS6 level we do observe zeros. One interpretation is that the desired import level is so low that it falls below the recorded level, or is done through third parties. Alternatively, these may be true zeros and we have to augment the model as described below. Variation at this level may capture large differences in incentives to adopt because of TPU and thus may be informative about the mechanism of the model but testing this empirically also requires care to ensure the zeros are not simply because an HS6 is outside the potential adoption set for firms in a given sector.

As a preliminary step, we ask whether the prevalence of zeros seems important a priori in the data. At an aggregate level almost all imports in this period occur in HS6 products China imported before and after accession (about 99% in 2005-2000) and they account for all of the growth. This aggregate masks churning at the firm level, but about three quarters of imports and import growth by continuing firms also occurs in HS6 products they already imported before WTO accession, as noted in the descriptive evidence section.[32] Even these firm aggregates mask potentially interesting heterogeneity across firms. In particular, they reflect an import weighted average of continuing firm-HS6 observations that should be more representative of the larger firms that have already adopted most potential inputs, as the model would predict. The evidence suggests this is the case and that smaller firms have a

example,

$$\Delta\bar{\beta}_h^m = \alpha(\sigma-1)\left[\Theta_0(1-\delta_0)(1+\xi_0) - E(s_0^*)\right] h\left(-\Delta\frac{u_t}{1+u_t}\right)$$

[32] Specifically, we construct a panel of continuing importing firms between 2000-2005; these account for 60% of total intermediate imports (averaged between those two years); we compute the imports in continuing firm-HS-6 pairs and find that it accounts for almost three quarters of their total imports and also a similar share of their import growth between 2000-2005.

lower share of trade in continuing HS6 products.[33] Thus it may be instructive to examine HS6 adoption to study the mechanism of the model.

Our theoretical model of Section 2 did not allow for zero imports of an input, because the firm always imports at least μ_{if} (the measure of the riskless foreign varieties), which is positive with probability 1. To allow for zero imports, therefore, we must require the distribution of μ to have a mass point at zero: $G(0) > 0$. The probability of observing a firm with *positive* imports in this subset is,

$$\Pr\left(n_{if}^{*u} > 0 | \mu_{if} = 0\right) = \begin{cases} 1 & \text{if } \tilde{\mu}_{if}^{u} > 0 \\ 0 & \text{if } \tilde{\mu}_{if}^{u} \leq 0 \end{cases}, \tag{37}$$

where the latent variable $\tilde{\mu}_{if}^{u}$ is given by (19). We showed that it is increasing in the firm's expected profits and decreasing in the own current tariff and TPU. In the appendix, we approximate it around $\tilde{\mu}_{if} = 0$—the point of adoption indifference under certainty—and it yields,

$$\tilde{\mu}_{if}^{u} \approx \Phi + \Phi_f + \Phi_i - (\theta - 1)\left[\ln \tau_i^l + \frac{u}{1+u} \ln\left(\frac{\tau_i^h}{\tau_i^l}\right)\right] \tag{38}$$

where the profit effect is subsumed in the firm fixed effect, Φ_f.

New input adoption

If we observed the subset of risky products for each firm then we could specify a probability model over fi in any given year using indicators $\mathbf{1}(m_{ift} > 0)$. We would have similar sign predictions to those derived in (28), e.g. higher probability of adoption post accession for i with higher initial risk, $\Delta\beta_h^y > 0$. However, without directly observing that subset we require an alternative approach; we focus on the adoption of new inputs described below.

According to the model if a firm f does not use an input i even though it is available and used by others then this is a risky variety for f. Using this insight the following adoption variable over the set of products a firm did not import pre-WTO includes only risky varieties.

$$adopt\_post_{if} = \begin{cases} 1 \text{ if } m_{if,post} > m_{if,pre} = 0 \\ 0 \text{ if } m_{if,post} = m_{if,pre} = 0 \end{cases} \text{and } i \in \mathcal{I}_{f \in F}$$

We use the subset of inputs $i \in \mathcal{I}_{f \in F}$, which are the potential products relevant for the

[33] Specifically, we compute the average continuing share, $\Sigma_{i \in cont}\left(m_{if,post} + m_{if,pre}\right) / \Sigma_i \left(m_{if,post} + m_{if,pre}\right)$, which has a simple average across firms of 0.39, considerably smaller than the import weighted average of 0.72. Similarly, the simple mean of the share of growth by continuous firm-products is lower than the weighted average.

production sector, F, that firm f belongs to.[34] In order to avoid timing issues and maximize the sample size in terms of firms we define the import variables over any pre and any post period and thus there is no time dimension in the new adoption variable.

The relevant set of potential inputs differs across sector. The fraction of new adoptions in the sample is seemingly low, 1.7%, but that reflects in part the large number of potential if pairs in the sample, almost 40 million. This implies almost 700,000 adoptions in the sample.

To interpret the estimated coefficients we can start with a linear probability model using $\mathbf{1}(m_{ift} > 0)$ following (28), which would yield coefficients β^y_τ and β^y_h with the same qualitative predictions described for import values. Now note that around no initial adoption $adopt\_post_{if} = \mathbf{1}(m_{if,post}) - \mathbf{1}(m_{if,pre})$ and using the changes over time operator, Δ, we obtain

$$adopt\_post_{if} = \Delta\beta^y_h \ln \frac{\tau^h_i}{\bar{\tau}_{ipre}} - \left(\beta^y_{\tau,pre} - \beta^y_{h,post}\right) \ln \bar{\tau}_{ipre} + \left(\beta^y_{\tau,post} - \beta^y_{h,post}\right) \ln \bar{\tau}_{ipost} + \Delta\mathbf{a}_{f,t} + \Delta e_{ift}. \tag{39}$$

The differencing implies we need only control for firm and time effects and the coefficient on pre-risk is the differential impact $\Delta\beta^y_h > 0$. If uncertainty was eliminated post accession then the coefficient on the initial tariff would simply be $-\beta^y_{\tau,pre} > 0$: higher adoption of products with initially higher tariffs, and the model predicts that is also the case even if uncertainty is not fully eliminated since $\beta^y_{\tau,pre} < \beta^y_{h,post}$. Finally, conditional on pre-tariffs, the higher tariffs are in the post period the lower the probability of new adoption since $\beta^y_{\tau,post} < \beta^y_{h,post}$.

The estimates in column 1 of Table 11 are consistent with all three predictions. The elasticity of new adoption with respect to tariff risk after a reduction in uncertainty is 4.7 at the mean. This implies that WTO accession increased the probability of new adoption for products with the mean tariff risk (0.07 in the data) relative to those without by about 33%.

A final exercise splits the sample into high and low productivity. According to the theory, firms on the margin of adoption of an HS6 should have an adoption elasticity which is independent of firm productivity, unlike the elasticities of values within an already-adopted HS6 which we examined in previous sections.[35] To construct productivity we loose about half the sample but still find a similar impact of uncertainty relative to the sample in column 1 (the tariff estimates are now too imprecise to identify). The uncertainty effect is present in both high and low productivity samples. Their point estimates differ but this merely reflects

[34] Specifically we construct the subset of all i ever imported by any firm in F in the sample period, i.e. $i \in \mathcal{I}_{f \in F}$ if $\max_{t,f' \in F}\{1(m_{if't} > 0) = 1\}$.

[35] The identification is from firms on the margin of adoption, so $\tilde{\mu}_{if} \approx 0$ and in the appendix we show that the risk elasticity of adoption around this point is $-(\theta - 1)\frac{u_t}{1+u_t}$, which is independent of firm productivity.

the fact that high productivity are twice as likely to adopt on average in the data. Thus the elasticities with respect to tariff risk at the mean are similar for high and low as predicted.

4.4 Quantification

We explore the estimates and model structure to do the following: (1) extract information about the probability of reversal, γ; (2) quantify how accession increased imported input values via substitution and complementarity and the impact this had on operating profits.

4.4.1 WTO Commitment Effect on Probability of Reform Reversal

The key uncertainty measure for firm investment is the expected duration in a worst case state. This is given by $u = \frac{\beta\gamma}{1-\beta}$, where β here is the firm discount factor (not an estimation coefficient) and γ is the transition probability to the worst state, where tariff reforms are reversed and protection increases. Using the relationship in (31) we used the estimates to quantify the percent reduction in a related uncertainty measure, $u/(1+u)$, of around -0.51 for the import baseline (Table 2, column 4). This is what we require and use below for the import quantification exercises. However, it is also interesting to examine what we learn about the underlying probability γ by using a reasonable value of β, e.g. 0.85. Doing so we can obtain a percent change in u, which is the same as that of $\Delta\gamma/\gamma^{pre}$, for any given γ^{pre}.[36]

We plot the γ post-WTO relative to its pre value in Figure 4. If there was no commitment effect then the probability would remain on the 45 degree line, the shaded area below it shows the percentage point reduction for any γ^{pre} using the import estimates. We find the post-WTO reversal probability is at most 0.13 (any $\gamma^{pre} \leq 1$) and its percent reduction is at least 64% (if $\gamma^{pre} \geq 0.13$).[37]

[36] To guide this choice we note that $\beta = (1-d)/(1+r)$ where d is the constant death rate of firms and r the real rate at which it discounts future profits. A $\beta = .85$ is consistent with alternative reasonable combinations of these parameters; e.g. $d = 0.125$ (similar to what other authors assume cf. Constantini and Melitz, 2008, p.24) and $r = 0.026$ (the median Chinese real interest rate). We would obtain a slightly higher value, 0.88, if we used $d = 0.10$ (the median of the fraction of firms that exit in China in 2000-2006).

[37] Handley and Limão estimate that Chinese exporters believed that the US would revert to column 2 tariffs with a probability of 0.13, so, assuming China would reverse its own tariffs in retaliation, this places a lower bound on γ^{pre}.

4.4.2 Substitution Effects

We compute the import substitution effects from the estimates in Table 2 and provide a simple decomposition of WTO accession. 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

$$\begin{aligned} E_{if} \ln \frac{m_{if}\left(u_{wto}, \tau_{i,wto}\right)}{m_{if}\left(u_{pre}, \tau_{i,pre}\right)} &= \underbrace{\left[\left(\beta^m_{\tau,wto} - \beta^m_{h,wto}\right) \cdot E_{if}\left(\Delta \ln \bar{\tau}_i\right)\right]}_{\Delta \text{Tariff}} + \underbrace{\left(\Delta \beta^m_h / h\right) \cdot \bar{r}_{pre}}_{(\Delta \text{TPU}) \cdot \text{Initial Risk}} \quad (40) \\ &= (-3.52) \cdot (-.05) + (3.99/0.49) \cdot 0.07 \\ &= 0.18 + 0.57 \end{aligned}$$

We take $E_{if}\left(\Delta \ln \bar{\tau}_i\right)$ as the change in intermediate tariffs between 2006-2000 averaged over all i traded in both periods: -5 log points (lp).[38] The TPU component requires a structural parameter that we recover from the estimates in column 2, $h = 0.49$, and a measure of initial risk, $\bar{r}_{pre}$, which we compute using the historical mean reversal: about 7 lp in 2000.[39] We find that the tariff change accounted for only about 1/4 of the predicted growth due to substitution effects. The other 3/4 are from locking in previous tariff reductions by lowering the belief they would be reversed. The conclusion is similar if we use the manufacturing sample in column 3.

Uncertainty attenuates the tariff elasticity considerably; even after accession it is still only -3.52. In a counterfactual where uncertainty is eliminated that elasticity would be around -11 so the tariff impact would have been about 3 times larger; but it would still only account for about one third of the overall growth since the commitment impact would also increase.[40] This highlights the importance of even small levels of uncertainty post-accession, $\gamma < 0.13$ as argued above, when magnified via adoption investments.

[38] Note this is more than the value in the regression sample, -4.5 log points, because the sample includes intermediate years where tariffs were being phased in. Since we estimate structural elasticities we can apply any reasonable tariff change.

[39] 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 $\ln \tau$ 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 $h = .57)$

[40] To see this we compute

$$\begin{aligned} E_{if} \ln \frac{m_{if}\left(u_{wto}, \bar{\tau}_{i,wto}\right)}{m_{if}\left(u_{pre}, \bar{\tau}_{i,pre}\right)} |_{u_{wto}=0} &= \beta_{\tau,wto}|_{u_{wto}=0} \cdot E_{if}\left(\Delta \ln \bar{\tau}_i\right) + \left(\Delta \beta_h / h\right)|_{u_{wto}=0} \cdot \bar{r}_{pre} \\ &= -11 \cdot (-.05) + (7.8/0.49) \cdot .07 \end{aligned}$$

4.4.3 Input Complementarity Effects

The substitution effects provide only a lower bound of the accession's impact on intermediate imports (since any complementarity effects are absorbed by firm-time effects in the baseline). We can expand the counterfactual expression in (40) to account for the complementarity effects estimated in Table 10 and denoted by $\bar{\beta}$. This yields a better approximation of the overall impact and the relative importance of complementarity vs. substitution.

$$\begin{aligned} E_{if} \ln \frac{m_{if}\left(u_{wto}, \tau_{i,wto}\right)}{m_{if}\left(u_{pre}, \tau_{i,pre}\right)} &> \left[\left(\beta^m_{\tau,wto} - \beta^m_{h,wto}\right)\right] \cdot E_{if}\left(\Delta \ln \bar{\tau}_i\right) + \left[\underbrace{\Delta\beta^m_h/h}_{\text{substitution}} + \underbrace{\Delta\bar{\beta}^m_h/h}_{\text{complementarity}}\right] \cdot \bar{r}_{pre} \\ &= 0.15 + (0.41 + 0.28) \end{aligned} \tag{41}$$

The righthand side is a lower bound because it omits the complementarity term for tariffs, $\left[\bar{\beta}^m_{\tau,wto} - \bar{\beta}^m_{h,wto}\right] \cdot E_{if}\left(\Delta \ln \bar{\tau}_i\right)$, which is positive according to the model. It is not included because our approach does not yield level profit effects. We use the manufacturing firm specification in Table 10, column 2. The substitution components are 15 lp for the tariff and 41 lp for the commitment effect.[41] The remaining 28 lp represent the complementarity component of commitment. Thus we obtain a lower bound impact of 84 log points, which is a substantial fraction of the growth observed in the data. For example, if we aggregate imports over manufacturing firms for each intermediate i then their real average growth was 141 lp between 2000-2006.[42]

The 28 log points is a significant fraction of the uncertainty related growth, about 40 percent. It is also instructive to note that this complementarity effect differs across firms' productivity: it is 36 log points for high and 29 for low (Table 10 columns 4 and 5), which is consistent with the theory.

where $\beta_{\tau,wto}|_{u_{wto}=0} \equiv \beta^m_\tau + \beta^m_h\left(1-h\right)/h$ and $\left(\Delta\beta_h/h\right)|_{u_{wto}=0} \equiv -\beta_{h,pre}/h$. We then have $\left[\beta_{\tau,wto}\right]_{u_{wto}=0} \cdot E_{if}\left(\Delta \ln \bar{\tau}_i\right) / \; E_{if} \ln \frac{m_{if}(u_{wto},\bar{\tau}_{i,wto})}{m_{if}(u_{pre},\bar{\tau}_{i,pre})}\Big|_{u_{wto}=0} = 0.34$.

[41] These substitution effects are similar to what we obtain in (40) using Table 1, column 1 (all firms) and most of the difference is accounted for by the sample; in fact if we re-compute the quantification in (40) using the sample of comparable manufacturing firms in column 3 we obtain nearly identical substitution effects to those in the estimation that also controls for profit effects. We use $h = .52$, which is similar to baseline and equal to geometric average of the h implied by the substitution and profit effects.

[42] Specifically, we compute $E_i \ln \frac{\Sigma_f m_{if2006}}{\Sigma_f m_{if2000}} = 161$ lp, and use the growth in Chinese GDP deflator in this period, 20 lp, to obtain the real growth.

4.4.4 Current Profit Effects

We showed that lower tariffs and tariff risk contributed significantly to Chinese firm intermediate import growth following WTO accession. This input expansion increases the firm's current operating profits. We can use the approximation in (24), to derive the following commitment effect on those profits

$$E_{\mu f} \ln \frac{\pi_f\left(u_{wto}, \tau_{pre}\right)}{\pi_f\left(u_{pre}, \tau_{pre}\right)} = \chi \cdot \left(\Delta\bar{\beta}_h^m/h\right) \cdot \bar{r}_{pre}, \tag{42}$$

where $\chi \equiv \frac{\Theta_0(1-\delta_0)-E\left(s_0^*\right)}{\Theta_0(1-\delta_0)(1+\xi_0)-E\left(s_0^*\right)} \leq 1$ since $\xi_0 \geq 1$.[43] It follows that the 25 log points found for the complementarity effect on imports in the previous subsection is also an upper bound for the impact on current operating profits.

We also provide a direct estimate of the profit effect based on (24). Specifically we use

$$\ln \pi_{ft} = \mathbf{a}_{f,t,I} + \Delta\bar{\beta}_\tau^\pi \cdot \mathbf{1}_{wto} \int_0^1 \ln \bar{\tau}_{jt} dj + \Delta\bar{\beta}_h^\pi \cdot \mathbf{1}_{wto} \int_0^1 \ln\left(\tau_j^h/\tau_j^l\right) dj + e_{ift}, \tag{43}$$

where profits are measured at the firm level by sales net of cost of goods sold. The RHS includes only the aggregate policy variables computed as in Table 10. In Table 12 column 1 we confirm the predictions from uncertainty reduction: $\Delta\bar{\beta}_\tau^\pi < 0 < \Delta\bar{\beta}_h^\pi$. Moreover, we can compute the commitment effect in (42) directly as $\left(\Delta\bar{\beta}_h^\pi/h\right) \cdot \bar{r}_{pre} = 3$ lp. The effect is 4.6 lp for profits per worker (column 2).

5 Conclusion

We provide a new model of input price uncertainty that captures both substitution and complementarity effects and derive its empirical implications. We test these using an important episode that lowered input price uncertainty but the insights apply to other settings.

Commitments to trade liberalization and trade agreements induce firms to make investments in new trade relationships and upgrades. Most research has focused on improved market access for exporters through reduced policy uncertainty in trade agreements. Our

[43] To obtain (42) we use 24 and difference it with respect to u_t:

$$E_{\mu f} \ln \frac{\pi_f\left(u_{wto}, \tau_{i,pre}\right)}{\pi_f\left(u_{pre}, \tau_{i,pre}\right)} = \underbrace{-\alpha(\sigma-1)\left[\Theta_0(1-\delta_0) - E\left(s_0^*\right)\right]\Delta\left(\frac{u_t}{1+u_t}\right)}_{\equiv \Delta\bar{\beta}_h^\pi/h} \times \underbrace{E_f \int_0^1 d\ln\left(\frac{\tau_i^h}{\tau_i^l}\right) di}_{\equiv \bar{r}_{pre}}.$$

Using the import equation complementarity coefficient and the definition of χ in the text we have $\Delta\bar{\beta}_h^\pi/h = \chi \times \left(\Delta\bar{\beta}_h^m/h\right)$.

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 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 show that accession reduced uncertainty and that WTO commitments for China's own import tariffs explain a considerable portion of the large increase in intermediate imports from 2000-2006 both through substitution and profit effects. 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 if recent increases in tariffs are reversed.

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A Appendix

A.1 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

A.2 Derivation of $z_i^{\frac{1}{1-\theta}}x_i=\alpha(\sigma-1)\pi$

The firm minimizes lagrangian $\int_0^1 z_i^{\frac{1}{1-\theta}}x_i+l+\lambda\left(\ln y-\ln\varphi-(1-\alpha)\ln l-\alpha\int_0^1\ln x_i di\right)$. First-order conditions are: $z_i^{\frac{1}{1-\theta}}x_i=\alpha\lambda y$ and $l=(1-\alpha)\lambda y$. Integrating and adding the FOCs gives: $\int_0^1 z_i^{\frac{1}{1-\theta}}x_i+l=\lambda y$ or $\lambda=\left(\int_0^1 z_i^{\frac{1}{1-\theta}}x_i+l\right)/y=c$. Thus, $z_i^{\frac{1}{1-\theta}}x_i=\alpha yc$. Replacing y with demand (1) and using $p=\frac{\sigma}{(\sigma-1)}c$, we have $z_i^{\frac{1}{1-\theta}}x_i=\alpha E\left(\frac{\sigma}{(\sigma-1)}c\right)^{-\sigma}c$. 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, $z_i^{\frac{1}{1-\theta}}x_i=\alpha(\sigma-1)\pi$.

A.3 Derivation of equation (19)

Equation (18) can be written as,

$$\frac{\kappa\pi^l}{1+u}+\frac{u\kappa\pi^h}{1+u}\frac{\rho_i^l+n_i^*}{\rho_i^l+n_i^*+\left(\rho_i^h-\rho_i^l\right)}\leq\rho_i^l+n_i^*$$

which is quadratic in $\rho_i^l+(n_i-\bar{n}_i)$. Simplifying gives,

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

where $x = \rho_i^l + n_i^*$, $a = \frac{\kappa\pi(z^l)}{1+u}$, $b = \frac{u\kappa\pi(z^h)}{1+u}$, $c = \rho_i^h - \rho_i^l$.

We can rule out the negative root (as n_i^{*u} is constrained to be non-negative), leaving

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

Let $\psi_i = \frac{1-\sqrt{1-\frac{4bc}{(a+b+c)^2}}}{2} = \frac{1}{2} - \frac{1}{2}\left(1 - \frac{u}{1+u}\frac{4\kappa\pi(z^h)\left(\rho_i^h-\rho_i^l\right)}{\left(\kappa\pi(z^l)U+\rho_i^h-\rho_i^l\right)^2}\right)^{1/2}$, then we have

$$\rho_i^l + n_i^* = \kappa\pi(z^l)U - \left(\kappa\pi(z^l)U + \rho_i^h - \rho_i^l\right)\psi_i$$
$$n_i^* = \kappa\pi(z^l)U\,(1-\psi_i) - \psi_i\left(\rho_i^h - \rho_i^l\right) - \rho_i^l$$

A.4 Proof of Lemma 1

Differentiating (17) with respect to n_j^{*u} gives,

$$V_{n_i^{*u}n_j^{*u}} = \frac{\pi_{z_iz_j}(z^l)\left(\tau_i^l\right)^{1-\theta}\left(\tau_j^l\right)^{1-\theta} + u\pi_{z_iz_j}(z^h)\left(\tau_i^h\right)^{1-\theta}\left(\tau_j^h\right)^{1-\theta}}{(1+u)(1-\beta)} > 0$$

Thus, V has strictly increasing differences in $\left(n_i^{*u}, n_j^{*u}\right)$ for $i,j \in \{1,...,N\}$ such that $i \neq j$. Differentiating (17) with respect to τ_j^h for $i \neq j$ gives,

$$V_{n_i^{*u}\tau_j^h} = (1-\theta)\,u\left(\tau_j^h\right)^{-\theta}\frac{\pi_{z_iz_j}(z^h)\left(\tau_i^h\right)^{1-\theta}n_j^{*u}}{(1+u)(1-\beta)} \leq 0$$

Thus, V has (weakly) decreasing differences in $\left(n_i^{*u}, \tau_j^h\right)$ for $i \neq j$. Differentiating (17) with respect to τ_i^h gives

$$V_{n_i^{*u}\tau_i^h} = (1-\theta)\,u\left(\tau_i^h\right)^{-\theta}\frac{\pi_{z_iz_i}(z^h)\left(\tau_i^h\right)^{1-\theta}n_i^{*u} + \pi_{z_i}(z^h)}{(1+u)(1-\beta)}.$$

Noting that $\pi_{z_iz_i}(z) = \pi_{z_i}(z)\frac{1}{z_i}\left(\alpha_i\frac{\sigma-1}{\theta-1} - 1\right)$, we obtain

$$\begin{aligned} V_{n_i^{*u}\tau_i^h} &= \frac{(1-\theta)\,u}{(1+u)(1-\beta)}\left(\tau_i^h\right)^{-\theta}\pi_{z_i}(z^h)\frac{1}{z_i^h}\left[\left(\alpha_i\frac{\sigma-1}{\theta-1} - 1\right)\left(\tau_i^h\right)^{1-\theta}n_i^{*u} + z_i^h\right] \\ &= \frac{(1-\theta)\,u}{(1+u)(1-\beta)}\left(\tau_i^h\right)^{-\theta}\pi_{z_i}(z^h)\frac{1}{z_i^h}\left[\left(\alpha_i\frac{\sigma-1}{\theta-1}\right)\left(\tau_i^h\right)^{1-\theta}n_i^{*u} + \bar{n}_i\right] < 0 \end{aligned}$$

Thus, V has strictly decreasing differences in $\left(n_i^{*u}, \tau_i^h\right)$ for i. Standard results from monotone comparative statics (e.g., see Van Zandt (2002), Theorem 5) imply that any high-tariff vectors τ^h and τ'^h such that $\tau^h > \tau'^h$, we have $n_i^{*u}\left(\tau^h\right) \leq n_i^{*u}\left(\tau'^h\right)$ for all i. As certainty is just the special case where $\tau'^h = \tau^l$, and $\tau^h > \tau^l$ by definition, the result is immediate.

Having established that $n_i^{*u} < n_i^{*c}$ (where n^{*c} is the optimal n^* under certainty), it follows that $\tilde{\mu}_i^u < \tilde{\mu}_i^c$. As $G(\tilde{\mu}_i^u)$ is increasing, we have $G(\tilde{\mu}_i^u) < G(\tilde{\mu}_i^c)$.

Finally, we establish that for a given productivity, operating profit under certainty is greater than the expected value of operating profit under uncertainty. Note that for any n^* it must be that $\pi\left(n^*, \tau^l\right) \geq \pi\left(n^*, \tau^h\right)$, and thus, evaluated at n^{*u}, we have,

$$\pi\left(n^{*u}, \tau^l\right) \geq \frac{1}{1+u}\pi\left(n^{*u}, \tau^l\right) + \frac{u}{1+u}\pi\left(n^{*u}, \tau^h\right)$$

A sufficient condition is therefore, $\pi\left(n^{*c}, \tau^l\right) \geq \pi\left(n^{*u}, \tau^l\right)$, where n^{*c} is the optimal n^* under certainty. As n^{*c} maximizes (8), it must be that

$$\frac{\pi\left(n^{*c}, \tau^l\right)}{1-\beta} - \int_0^1 K n_i^{*c} di \geq \frac{\pi\left(n^{*u}, \tau^l\right)}{1-\beta} - \int_0^1 K n_i^{*u} di$$

$$\frac{\pi\left(n^{*c}, \tau^l\right)}{1-\beta} - \frac{\pi\left(n^{*u}, \tau^l\right)}{1-\beta} \geq \int_0^1 K\left(n_i^{*c} - n_i^{*u}\right) di$$

Thus, the sufficient condition holds if and if $\int_0^1 K\left(n_i^{*c} - n_i^{*u}\right) di \geq 0$, which must be true given $n_i^{*u} < n_i^{*c}$. QED.

A.5 Proof of Proposition 1

Taking the ratio of (20) to (12) gives

$$\begin{aligned} m_i^{*u}/m_i^{*c} &= \frac{\pi^u(z^l)\frac{n_i^{*u}\left(\tau_i^l\right)^{1-\theta}}{\bar{n}_i + n_i^{*u}\left(\tau_i^l\right)^{1-\theta}}}{\pi^c\frac{n_i^{*c}\left(\tau_i^l\right)^{1-\theta}}{\bar{n}_i + n_i^{*c}\left(\tau_i^l\right)^{1-\theta}}} \\ &= \frac{\pi^u(z^l)}{\pi^c(z)} \cdot \left(\frac{n_i^{*u}}{\bar{n}_i + n_i^{*u}\left(\tau_i^l\right)^{1-\theta}} / \frac{n_i^{*c}}{\bar{n}_i + n_i^{*c}\left(\tau_i^l\right)^{1-\theta}}\right) \end{aligned}$$

Lemma 1 established that $n_i^{*u} \geq n_i^{*c}$ and the proof showed that, $\pi^u(z^l) \leq \pi^c(z^l)$. Thus, $m_i^{*u}/m_i^{*c} \leq 1$. QED.

A.6 Three State Model

Our model includes only downside risk (i.e., a positive probability of transitioning to a less favorable state than the current one). In many irreversible investment problems, this focus is without loss of generality, because of the "bad news principle" (Bernanke, 1983): when firms can wait and see before making investments then only the expected severity of bad news matters. Here we confirm the applicability of this principle to our setting.

Consider an alternative model with three states: the current state l, and two absorbing states, h and g, where $\tau^h > \tau^l > \tau^g$. Let γ denote the probability of switching from the current state, and let ϖ denote the probability of g conditional on switching.

For any absorbing state s and "legacy" vector of imported varieties n^*, the optimal vector of imported varieties is:

$$\hat{n}_i^* \left(\tau^s \mid n^*\right) = \max\left\{\tilde{\mu}_i(\tau^s), n_i^*\right\}$$

where

$$\tilde{\mu}(\tau^s) = \arg\max_{n_i^{*\prime}} \left[\frac{\pi\left(n_i^{*\prime}, \tau^s\right)}{1-\beta} - K \cdot \int_0^1 n_i^{*\prime} di\right]$$

Following the proof of lemma 1, the maximand above has strictly increasing differences in $\left(n_i^{*\prime}, n_j^{*\prime}\right)$ for all $i \neq j$ and strictly decreasing differences in $\left(n^{*\prime}, \tau\right)$ which implies that $\tilde{\mu}(\tau^g) > \tilde{\mu}(\tau^l) > \tilde{\mu}(\tau^h)$.

As in the main text, we denote the choice under uncertainty as $n_i^{*u} = \max\left\{\tilde{\mu}_i^u, \mu_i\right\}$, where $\tilde{\mu}^u$ is the unconstrained optimum of the full problem, beginning in state l. Note that in this problem, n^{*u} is the common legacy vector for states g and h. It follows that if $\tilde{\mu}^u \in \left[\tilde{\mu}(\tau^h), \tilde{\mu}(\tau^l)\right]$, then

$$\tilde{\mu}(\tau^g) > \tilde{\mu}^u \geq \tilde{\mu}(\tau^h)$$

and thus, $\hat{n}_i^* \left(\tau^h \mid n_i^{*u}\right) = n_i^{*u}$ and $\hat{n}_i^* \left(\tau^g \mid n_i^{*u}\right) = \max\left\{\tilde{\mu}_i(\tau^g), \mu_i\right\}$. Critically, $\hat{n}_i^* \left(\tau^g \mid n_i^{*u}\right)$ does not depend on $\tilde{\mu}^u$; rather, it is only a function of the exogenous component of n_i^{*u}, namely, μ_i. This implies that a marginal change $\tilde{\mu}^u$ (the endogenous component of n_i^{*u}) will not affect either $\hat{n}_i^* \left(\tau^g \mid n_i^{*u}\right)$ or the continuation payoff in state g (so the latter can be treated as exogenous in the full problem, and it drops out of the first-order condition, as we show below).

To formally show these points we first define the present discounted value of profits gross of initial sunk costs in state l recursively by,

$$\begin{aligned} \Pi\left(n^*, \tau^l\right) &= \pi\left(n^*, \tau^l\right) + \beta(1-\gamma)\Pi\left(n^*, \tau^l\right) \\ &\quad + \beta\gamma\left[(1-\varpi)\hat{V}\left(\tau^h \mid n^*\right) + \varpi\hat{V}\left(\tau^g \mid n^*\right)\right], \end{aligned} \tag{44}$$

where for the extreme absorbing states $s = g, h$ we have

$$\hat{V}\left(\tau^s \mid n^*\right) = \max_{n_i^{*\prime}} \left[\frac{\pi\left(n_i^{*\prime}, \tau^s\right)}{1-\beta} - K \cdot \int_0^1 \left(n_i^{*\prime} - n_i^*\right) \mathbf{1}_{\left[\mathbf{n_i^{*\prime}} > \mathbf{n_i^*}\right]} di\right]. \tag{45}$$

The indicator function $\mathbf{1}_{\left[\mathbf{n_i^{*\prime}} > \mathbf{n_i^*}\right]}$ is unity if varieties are added beyond those from state l and zero otherwise.

Solving (44) and subtracting the initial sunk costs yields the firm's initial state objective function—it maximizes:

$$V\left(n^*, \tau^l\right) = \frac{1}{(1+u)} \frac{\pi\left(n^*, \tau^l\right)}{(1-\beta)} - K \cdot \int_0^1 \left(n_i^* - \mu_i\right) di + \frac{u}{(1+u)} \left[(1-\varpi)\hat{V}\left(\tau^h \mid n^*\right) + \varpi \hat{V}\left(\tau^g \mid n^*\right)\right] \tag{46}$$

subject to $n_i^* \geq \mu_i$. Note that $\hat{n}_i^*\left(\tau^h \mid n_i^{*u}\right) = n_i^{*u}$ and $\hat{n}_i^*\left(\tau^g \mid n_i^{*u}\right) = \max\left\{\tilde{\mu}_i(\tau^g), \mu_i\right\}$ implies,

$$V\left(n^*, \tau^l\right) = \frac{1}{(1+u)} \frac{\pi\left(n^*, \tau^l\right)}{(1-\beta)} - K \cdot \int_0^1 \left(n_i^* - \mu_i\right) di + \frac{u(1-\varpi)}{(1+u)} \frac{\pi\left(n^*, \tau^h\right)}{(1-\beta)} + \frac{u\varpi}{(1+u)} \left[\frac{\pi\left(\max\left\{\tilde{\mu}(\tau^g), \mu\right\}, \tau^s\right)}{1-\beta} - K \cdot \int_0^1 \left(\max\left\{\tilde{\mu}_i(\tau^g), \mu_i\right\} - n_i^*\right) di\right] \tag{47}$$

The first-order condition for $n_i^* > \mu_i$ is thus

$$0 = \frac{1}{(1+u)} \frac{\pi^l_{n_i^*}}{(1-\beta)} - K + \frac{u(1-\varpi)}{(1+u)} \frac{\pi^h_{n_i^*}}{(1-\beta)} + \frac{u\varpi}{(1+u)} K$$

Letting $u' = u(1-\varpi)$, the first-order condition becomes

$$K = \frac{1}{(1+u')} \frac{\pi^l_{n_i^*}}{(1-\beta)} + \frac{u'}{(1+u')} \frac{\pi^h_{n_i^*}}{(1-\beta)}$$

which is the same first-order condition as in the two-state model in the main text with $u' < u$ if $\varpi > 0$ since the probability of the worst case scenario is lower. Moreover, the solution to this problem is such that $\tilde{\mu}^u \in \left[\tilde{\mu}(\tau^h), \tilde{\mu}(\tau^l)\right]$. Hence the addition of a third state more favorable than the current state has no effect on our results, it simply changes the interpretation as described in the text.

A.7 Derivation of Approximations

We wish to approximate $E_\mu \ln\left(m_i^{*u}\right)$ and $E_\mu \ln\left(\pi^l\right)$ around $(\tau_0, \bar{n}_0, \varphi_0)$. We start with

$$E_\mu \ln\left(m_i^{*u}\right) = \ln \alpha (\sigma - 1) + \ln \pi^l + G(\tilde{\mu}_i) \ln\left(\frac{\tilde{\mu}_i}{\rho_i^l + \tilde{\mu}_i}\right) + \int_{\tilde{\mu}_i}^{\infty} \ln\left(\frac{\mu}{\rho_i^l + \mu}\right) d\mu$$

and $\tilde{\mu}_i^u = (1-\psi_i)\kappa\pi^l U - \psi_i\left(\rho_i^h - \rho_i^l\right) - \rho_i^l$. Differentiating gives,

$$dE_\mu \ln\left(m_i^{*u}\right) = d\ln\left(\pi^l\right) + G(\tilde{\mu}_0)\left(1 - \tilde{s}_0^*\right)\left(d\ln\left(\tilde{\mu}_i\right) - d\ln\rho_i^l\right) - \delta_0 d\ln\rho_i^l$$

and ifferentiating $\tilde{\mu}_i^u$ gives,

$$d\ln\left(\tilde{\mu}_i^u\right)=\left(\frac{\alpha\kappa\pi_0}{\alpha\kappa\pi_0-\rho_0}\right)d\ln\left(\pi^l U\right)-d\psi_i\left(\frac{\alpha\kappa\pi_0}{\alpha\kappa\pi_0-\rho_0}\right)-d\ln\rho_i^l\left(\frac{\rho_0}{\alpha\kappa\pi_0-\rho_0}\right)$$

Recall that,

$$\psi_i=\frac{1}{2}-\frac{1}{2}\left(1-\frac{u}{1+u}\frac{4\kappa\pi^h\left(\rho_i^h-\rho_i^l\right)}{\left(\kappa\pi^l U+\rho_i^h-\rho_i^l\right)^2}\right)^{1/2}$$

And thus $d\psi_i$ evaluated at $(\tau_0,\bar{n}_0,\varphi_0)$ is

$$d\psi_i=\frac{u}{1+u}\frac{\rho_0}{\alpha\kappa\pi_0}d\ln\left(\frac{\rho_i^h}{\rho_i^l}\right)$$

Using $d\psi_i$ and $\tilde{s}_0^*=\frac{\alpha\kappa\pi_0-\rho_0}{\alpha\kappa\pi_0}$ in $d\ln\left(\tilde{\mu}_i^u\right)$ produces,

$$d\ln\left(\tilde{\mu}_i\right)=\frac{1}{\tilde{s}_0^*}d\ln\left(\pi^l U\right)-\frac{1-\tilde{s}_0^*}{\tilde{s}_0^*}\left[d\ln\rho_i^l+\frac{u}{1+u}\left(d\ln\frac{\rho_i^h}{\rho_i^l}\right)\right] \tag{48}$$

Using (48) and simplifying gives the approximation,

$$E_\mu\ln\left(m_i^{*u}\right)\approx E_\mu\ln\left(m_0^{*u}\right)+\ln\left(\frac{\pi^l}{\pi_0}\right)+\xi_0\ln\left(\frac{\pi^l U}{\pi_0}\right)-\left(\xi_0+\delta_0\right)\ln\left(\frac{\rho_i^l}{\rho_0}\right)-\xi_0\left(1-\tilde{s}_0^*\right)\frac{u}{1+u}\ln\left(\frac{\rho_i^h}{\rho_i^l}\right) \tag{49}$$

If we were only interested in the effects of own current tariff and own TPU, then (49) would suffice. However, to obtain effects of aggregate tariffs and TPU, we need to unpack $\ln\left(\pi^l\right)$ and $\ln\left(\pi^l U\right)$. Taking derivatives gives,

$$d\ln\left(\pi^l\right)=d\ln\left(\varphi^{\sigma-1}\right)+\frac{\alpha\left(\sigma-1\right)}{\theta-1}\int_0^1 dE_\mu\ln z_i^l di \tag{50}$$

$$d\ln\left(\pi^l U\right)=d\ln\left(\varphi^{\sigma-1}\right)+\frac{\alpha\left(\sigma-1\right)}{\theta-1}\left\{\frac{1}{1+u}\int_0^1 dE_\mu\ln z_i^l di+\frac{u}{1+u}\int_0^1 dE_\mu\ln z_i^h di\right\} \tag{51}$$

from which we get,

$$d\ln\left(U\right)=\frac{\alpha\left(\sigma-1\right)}{\theta-1}\frac{u}{1+u}\int_0^1\left(dE_\mu\ln z_i^h-dE_\mu\ln z_i^l\right)di$$

For $s=l,h$, we have

$$dE_\mu\ln z_i^s=d\ln\left(\bar{n}_i\right)+\left[\frac{\tilde{\mu}_i}{\rho_i^s+\tilde{\mu}_i}\left(d\ln\tilde{\mu}_i-d\ln\rho_i^s\right)G(\tilde{\mu}_i)-\left(\int_{\ln\tilde{\mu}_i}^{\infty}\frac{\mu}{\rho_i^s+\mu}g(\mu)d\mu\right)d\ln\rho_i^s\right]$$

which valuated at $(\tau_0, \bar{n}_0, \varphi_0)$ becomes

$$dE_\mu \ln z_i^s = d\ln(\bar{n}_i) + \tilde{s}_0^* G(\tilde{\mu}_0)\left(d\ln\tilde{\mu}_i\right) - E_\mu\left(s_0^*\right)\left(d\ln\rho_i^s\right) \tag{52}$$

where $E_\mu\left(s_0^*\right) = (1-\delta_0) - (1-\tilde{s}_0^*)\, G(\tilde{\mu}_0)$. Hence, we can already obtain an approximation for $\ln(U)$:

$$\ln(U) \approx -\frac{\alpha(\sigma-1)}{\theta-1}\frac{u}{1+u}E_\mu\left(s_0^*\right)\int_0^1 \ln\left(\frac{\rho_i^h}{\rho_i^h}\right)di \tag{53}$$

Integrating (52) over i and taking the weighted average over the two possible states gives,

$$\frac{1}{1+u}\int_0^1 dE_\mu \ln z_i^l di + \frac{u}{1+u}\int_0^1 dE_\mu \ln z_i^h di = d\ln(\bar{n}_i) + \tilde{s}_0^* G(\tilde{\mu}_0)\int_0^1 d\ln\tilde{\mu}_i di$$
$$- E_\mu\left(s_0^*\right)\left(\int_0^1 d\ln\rho_i^l di + \frac{u}{1+u}\int_0^1 d\ln\left(\frac{\rho_i^h}{\rho_i^l}\right)di\right)$$

Substituting this expression into (51) gives,

$$d\ln\left(\pi^l U\right) = d\ln\left(\varphi^{\sigma-1}\right) + \frac{\alpha(\sigma-1)}{\theta-1}\left\{\int_0^1 d\ln(\bar{n}_i)\,di + \tilde{s}_0^* G(\tilde{\mu}_0)\int_0^1 d\ln\tilde{\mu}_i di\right\} \tag{54}$$

$$-\frac{\alpha(\sigma-1)}{\theta-1}E_\mu\left(s_0^*\right)\left(\int_0^1 d\ln\rho_i^l di + \frac{u}{1+u}\int_0^1 d\ln\left(\frac{\rho_i^h}{\rho_i^l}\right)di\right) \tag{55}$$

Integration of (48) over all i, gives,

$$\int_0^1 d\ln\tilde{\mu}_i di = \frac{1}{\tilde{s}_0^*}d\ln\left(\pi^l U\right) - \frac{1-\tilde{s}_0^*}{\tilde{s}_0^*}\left[\int_0^1 d\ln\rho_i^l di + \frac{u}{1+u}\left(\int_0^1 d\ln\left(\frac{\rho_i^h}{\rho_i^l}\right)di\right)\right]$$

Substituting this expression into (54) allows us to approximate $\ln\left(\pi^l U\right)$ as:

$$\ln\left(\frac{\pi^l U}{\pi_0}\right) \approx \Theta\left[(\sigma-1)\ln\left(\frac{\varphi}{\varphi_0}\right) + \frac{\alpha(\sigma-1)}{\theta-1}\int_0^1 \ln\left(\frac{\bar{n}_i}{\bar{n}_0}\right)di\right]$$
$$-\ \Theta\frac{\alpha(\sigma-1)}{\theta-1}(1-\delta_0)\left(\int_0^1 \ln\left(\frac{\rho_i^l}{\rho_0}\right)di + \frac{u}{1+u}\int_0^1 \ln\left(\frac{\rho_i^h}{\rho_i^l}\right)di\right) \tag{56}$$

Using (56) and (53) in $\ln\left(\frac{\pi^l}{\pi_0}\right) = \ln\left(\frac{\pi^l U}{\pi_0}\right) - \ln(U)$, gives the approximation for $\ln\left(\pi^l\right)$ in the main text, and using using (56) and (53) in (49) produces equation (22) in the main text.

B Data and Estimation Appendix

B.1 Data sources and definitions of main variables

- *Tariff* ($\ln \tau_{it}$) Log of 1 plus the Chinese statutory MFN tariff rate in the HS6 product i in each year t, 2000-2006. HS6 codes are concorded to the 1996 version. Source: TRAINS via WITS except when missing (2002 for which we use WTO data).
- *Tariff Risk* ($\ln \tau_{ih} - \ln \tau_{it}$) where τ_{it} is 1 plus the Chinese average MFN tariff rate in the HS6 product i and τ_{ih} is the threat tariff factor: the historical mean in each i product in 1992-1999 (baseline) or the maximum of i in 1992-199 (robustness).
- *Imports:* log of Chinese ordinary (non-processing) import value in a firm-HS6-year. Source: Chinese Customs.
- *Import Dummy:* Chinese ordinary (non-processing) import dummy equal to 1 if a firm imports an intermediate HS6 and 0 otherwise in each year, 2000-2006. Used to construct adoption variable. Source: 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. Source: Chinese Customs.
- *Manufacturing Firms:* Firm in Chinese Census with CIC industrial codes from 13-43 matched to customs data using their names, zip codes and telephone numbers. Source: Chinese Customs and production data from the Chinese Bureau of Statistics.
- *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.
- *Intermediates:* Product categories based on UN BEC classification. Source: UN BEC classification.

Table 1. Summary Statistics of Variables in Main Regressions

	N	Mean	SD
I. Firm-product Intermediate Imports (Tables 2, 3, 6, 7)			
Imports (ln)	4,466,183	7.764	2.950
Tariff Risk-Pre	909,120	0.071	0.048
Tariff Risk-Post	3,557,063	0.119	0.067
Tariff-Pre	909,120	0.121	0.050
Tariff-Post	3,557,063	0.075	0.040
Tariff Risk-Pre(max)	909,120	0.167	0.106
Tariff Risk-Post(max)	3,557,063	0.216	0.121
II. Firm-product New Imported Intermediate Adoption (Table 11)			
New Adoption	39,308,933	0.017	0.131
Tariff Risk-Pre	39,308,933	0.072	0.051
Tariff-Pre	39,308,933	0.127	0.057
Tariff-Post	39,308,933	0.082	0.041

Notes: Imports are (ln) of $US of each intermediate HS6 good imported by individual firms in a given year. Tariffs (ln) are 1 plus the Chinese statutory MFN tariff rates at the hs6-year level. Tariff Risk 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. Tariff Risk (max) replaces the mean with the max in a given HS6 in 1992-1999. Post is a post-WTO dummy that is equal to 1 for years since 2002, and 0 otherwise.

Table 2. Intermediates Import Value

Dependent Variable = Firm-HS6 Imports (ln)

	1	2	3	4
Tariff Risk			-8.029***	-7.844***
			[0.543]	[0.538]
Tariff Risk×Post			3.983***	3.985***
			[0.592]	[0.593]
Tariffs	-6.074***	-5.941***	-3.308***	-3.182***
	[0.473]	[0.475]	[0.519]	[0.508]
Tariffs×Post	-1.986***	-1.943***	-4.233***	-4.194***
	[0.581]	[0.591]	[0.620]	[0.613]
Fixed Effects	f+t+s	ft+s	f+t+s	ft+s
N	4,551,009	4,466,183	4,551,009	4,466,183
R^2	0.286	0.329	0.293	0.335

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. Tariff Risk 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 3. Intermediates Import Value - Robustness to Firm and Product Sample

Dependent Variable = Firm-HS6 Imports (ln)

Firm sample	All		Manufacturing	
Import period	Any	Pre and Post	Any	Pre and Post
	1	2	3	4
Tariff Risk	-7.844***	-8.010***	-5.640***	-5.894***
	[0.538]	[0.651]	[0.527]	[0.645]
Tariff Risk×Post	3.985***	3.358***	2.893***	2.932***
	[0.593]	[0.727]	[0.598]	[0.732]
Tariffs	-3.182***	-3.433***	-2.103***	-1.650**
	[0.508]	[0.657]	[0.522]	[0.655]
Tariffs×Post	-4.194***	-3.596***	-3.631***	-3.324***
	[0.613]	[0.790]	[0.642]	[0.793]
Fixed Effects	ft+s	ft+s	ft+s	ft+s
N	4,466,183	1,178,469	1,665,714	537,922
R^2	0.335	0.333	0.286	0.301

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. Tariff Risk 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). Pre and post period indicates that the f-HS6 pair was imported in at least one year pre and one post accession. Manufacturing firm subsample: those matched to production census.

Table 4. Intermediates Import Value - SOE and non-SOE Firm Samples

Dependent Variable = Firm-HS6 Imports (ln)

	State Owned		Non-State Owned	
	1	2	3	4
Tariff Risk	-11.92***	-11.52***	-5.777***	-5.610***
	[0.711]	[0.695]	[0.483]	[0.484]
Tariff Risk×Post	5.312***	5.201***	2.738***	2.716***
	[0.750]	[0.735]	[0.541]	[0.551]
Tariffs	-4.836***	-4.719***	-2.020***	-1.767***
	[0.671]	[0.656]	[0.463]	[0.454]
Tariffs×Post	-5.792***	-5.685***	-4.058***	-4.160***
	[0.791]	[0.776]	[0.575]	[0.572]
Fixed Effects	f+t+s	ft+s	f+t+s	ft+s
N	1,171,481	1,160,895	3,379,426	3,305,288
R^2	0.25	0.29	0.305	0.348

Notes: Dependent variable imports (ln) are Chinese import values defined at the firm-hs6-year level. Subsamples defined based on the firm ownership information in Chinese customs data. Tariffs (ln) are 1 plus the Chinese statutory MFN tariff rates at the hs6-year level. Tariff Risk 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. Intermediates Import Value - Variation by Firm Export Status

Dependent Variable = Firm-HS6 Imports (ln)

	Never Exporters		Always Exporters		New Exporters	
	1	2	3	4	5	6
Tariff Risk	-5.569***	-5.237***	-8.255***	-8.112***	-7.187***	-6.870***
	[0.528]	[0.523]	[0.548]	[0.549]	[0.624]	[0.589]
Tariff Risk×Post	2.443***	2.209***	3.629***	3.647***	3.750***	3.611***
	[0.609]	[0.607]	[0.588]	[0.598]	[0.692]	[0.667]
Tariffs	-1.639***	-1.451***	-3.550***	-3.399***	-2.668***	-2.171***
	[0.473]	[0.465]	[0.536]	[0.528]	[0.568]	[0.543]
Tariffs×Post	-3.943***	-3.860***	-4.420***	-4.481***	-4.319***	-4.722***
	[0.622]	[0.625]	[0.636]	[0.630]	[0.712]	[0.693]
Fixed Effects	f+t+s	ft+s	f+t+s	ft+s	f+t+s	ft+s
N	485,104	462,189	1,612,633	1,602,324	295,458	290,141
R^2	0.481	0.513	0.228	0.27	0.287	0.342

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 (in post-WTO). Tariffs (ln) are 1 plus the Chinese statutory MFN tariff rates at the hs6-year level. Tariff Risk 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. Intermediates Import Value - Robustness to Export TPU

Dependent Variable = Firm-HS6 Imports (ln)

Firm sample	All		Manufacturing	
Input sample	All	Continuing Exporter country-HS6	All	Continuing Exporter country-HS6-manuf. sector
	1	2	3	4
Tariff Risk	-7.844***	-7.766***	-5.640***	-5.795***
	[0.538]	[0.562]	[0.527]	[0.794]
Tariff Risk×Post	3.985***	3.889***	2.893***	3.179***
	[0.593]	[0.619]	[0.598]	[0.888]
Tariffs	-3.182***	-3.225***	-2.103***	-2.148***
	[0.508]	[0.536]	[0.522]	[0.804]
Tariffs×Post	-4.194***	-4.117***	-3.631***	-3.890***
	[0.613]	[0.647]	[0.642]	[0.982]
Fixed Effects	ft+s	ft+s	ft+s	ft+s
N	4,466,183	4,223,751	1,665,714	548,024
R^2	0.335	0.335	0.286	0.355

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. Tariff Risk 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). "Continuing Exporter country-HS6" includes exporter country-HS6 pairs with positive imports in all sample years. "Continuing Exporter country-HS - manuf. sector" includes exporter country-HS6 pairs with positive imports in all sample years for firm's CIC industry. Manufacturing firm subsample: those matched to production census.

Table 7. Intermediates Import Value - Robustness to Alternative Risk Measure

Dependent Variable = Firm-HS6 Imports (ln)

Tariff Threat	Baseline Historical Avg	Alternative Measure Historical Max
	1	2
Tariff Risk	-7.844***	-3.760***
	[0.538]	[0.237]
Tariff Risk×Post	3.985***	1.108***
	[0.593]	[0.269]
Tariffs	-3.182***	-2.946***
	[0.508]	[0.510]
Tariffs×Post	-4.194***	-3.180***
	[0.613]	[0.614]
Fixed Effects	ft+s	ft+s
N	4,466,183	4,466,183
R^2	0.335	0.338

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. Tariff Risk is measured in column 2 as $\ln(\tau_{max}/\tau_t)$, where τ_{max} is (1 plus) Chinese maximum 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. Import Value - Intermediates vs. Consumption Goods

Dependent Variable = Firm-HS6 Imports (ln)

Firm sample	All		Manufacturing	
BEC classification	Intermediate	Consumption	Intermediate	Consumption
	1	2	3	4
Tariff Risk	-7.844***	-1.400***	-5.640***	0.137
	[0.538]	[0.519]	[0.527]	[0.951]
Tariff Risk×Post	3.985***	1.909***	2.893***	1.271
	[0.593]	[0.530]	[0.598]	[0.975]
Tariffs	-3.182***	-1.005**	-2.103***	-0.782
	[0.508]	[0.415]	[0.522]	[0.744]
Tariffs×Post	-4.194***	-2.457***	-3.631***	-2.137***
	[0.613]	[0.468]	[0.642]	[0.805]
Fixed Effects	ft+s	ft+s	ft+s	ft+s
N	4,466,183	738,919	1,665,714	149,668
R^2	0.335	0.425	0.286	0.443

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. Tariff Risk 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). Manufacturing firm subsample: those matched to production census.

Table 9. Intermediates Import Value - High vs. Low Initial Productivity

Dependent Variable = Firm-HS6 Imports (ln); Sample: pre and post HS6-firm

Firm productivity sample	High	Low	Pooled		
Coefficient	All	All	Low	High-Low Diff.	High-Low Diff.
	1	2	3		4
Tariff Risk	-5.946***	-6.061***	-6.005***	0.0275	-0.189
	[0.666]	[0.705]	[0.682]	[0.397]	[0.367]
Tariff Risk×Post	3.216***	2.405***	2.270***	0.995**	0.820**
	[0.757]	[0.789]	[0.769]	[0.452]	[0.417]
Tariffs	-1.680**	-1.088	-1.353**	-0.26	-0.352
	[0.692]	[0.677]	[0.665]	[0.427]	[0.386]
Tariffs×Post	-3.889***	-2.634***	-2.499***	-1.439***	-0.869*
	[0.846]	[0.823]	[0.803]	[0.537]	[0.488]
Fixed Effects	ft+s	ft+s	ft+s		ft+hs6t
N	337,276	142,090	479,366		476,697
R^2	0.263	0.358	0.295		0.415

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. Tariff Risk 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), hs6t denotes hs6 by year. All observations are for firm-HS6 pairs imported in at least one year pre and one post accession. Manufacturing firms matched to production census: Productivity measured by real output/worker in pre WTO period; High subsample if above median productivity of all firms within the same CIC industry, low otherwise.

Table 10. Intermediates Import Value - Profit Effects

Dependent Variable = Firm-HS6 Imports (ln)

Firm productivity sample	All	All	All	High	Low
Import period	Any	Any	Pre and post	Pre and post	Pre and post
	1	2	3	4	5
Tariff Risk	-5.826***	-5.856***	-5.947***	-5.969***	-5.973***
	[0.528]	[0.531]	[0.572]	[0.602]	[0.642]
Tariff Risk×Post	2.964***	3.006***	2.981***	3.090***	2.510***
	[0.586]	[0.593]	[0.642]	[0.676]	[0.711]
Tariffs	-2.405***	-2.425***	-2.445***	-2.480***	-1.993***
	[0.528]	[0.530]	[0.599]	[0.634]	[0.660]
Tariffs×Post	-3.467***	-3.455***	-3.193***	-3.478***	-2.471***
	[0.641]	[0.645]	[0.722]	[0.765]	[0.781]
Mean Tariff Risk×Post		2.043***	2.183***	2.325***	1.922*
		[0.317]	[0.741]	[0.697]	[1.123]
Mean Tariffs(ln)×Post		-1.523**	-2.757*	-2.878*	-2.363*
		[0.635]	[1.564]	[1.645]	[1.381]
Fixed Effects	f+t+s	f+t+s	f+t+s	f+t+s	f+t+s
N	1,690,405	1,690,405	975,421	703,181	207,467
R^2	0.246	0.246	0.234	0.208	0.311

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. Tariff Risk 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). Manufacturing firm subsample: those matched to production census. Mean Tariff Risk/tariff: average Tariff Risk/tariff of all products imported by any firm in the CIC that the firm produces in. Pre and post requires the imported inputs used in a given CIC to have been imported in at least one period before and one after. Manufacturing firms matched to production census: Productivity measured by real output/worker in pre WTO period; High subsample if above median productivity of all firms within the same CIC industry, low otherwise.

Table 11. New Imported Intermediate Adoption

Dependent Variable = 1 if firm-HS6 import =0 pre and >0 in post

Firm sample	All manufacturing	Productivity sample (pre Y/L)	High pre Y/L	Low pre Y/L
Type	Intermediate			
	1	2	3	4
Pre Tariff Risk	0.0795***	0.0624***	0.0801***	0.0440***
	[0.0199]	[0.0169]	[0.0222]	[0.0117]
Pre Tariffs	0.0254**	-0.0111	-0.0188	-0.00299
	[0.0114]	[0.0171]	[0.0228]	[0.0115]
Post Tariffs	-0.0857***	-0.00872	-0.00663	-0.0111
	[0.0242]	[0.0196]	[0.0261]	[0.0133]
Fixed Effects	f+s	f+s	f+s	f+s
N	39,308,933	20,380,945	10,384,043	9,996,902
R^2	0.072	0.075	0.083	0.053

Notes: Dependent Variable=1 if firm-HS6 import =0 pre and import>0 in post for subsample of products any firm in the same CIC as f imported in at least one year. Tariffs (ln) are 1 plus the Chinese statutory MFN tariff rates at the hs6-year level. Tariff Risk 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). Manufacturing firm subsample: those matched to production census. Productivity subsamples: those firms with census data that allow computing real output per worker (Y/L).

Table 12. Firm Profit Effects from Intermediates

	1	2
Dependent variable (ln):	Profits	Profits/Worker
Mean Tariff Risk×Post	0.174**	0.286***
	[0.0781]	[0.0640]
Mean Tariffs×Post	-0.334*	-0.487***
	[0.183]	[0.153]
Fixed Effects	f+t+s	f+t+s
N	158,422	158,422
R^2	0.866	0.814

Notes: Dependent variables in ln are Profits=sales-cost of goods sold, Profit/worker. Mean variables are defined as described in Table 8. 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 A1. Dynamics of Chinese Imports, 2000-2006

Type of Imports	Ordinary + Processing	Ordinary (OI)							
Decomposition	All	All		By good: Intermediates		By ownership: State-Owned		By trading type: Intermediaries	
	Value	Value	Share of OI +Processing	Value	Share of OI	Value	Share of OI	Value	Share of OI
2000	225	133	59%	90	68%	72	54%	43	32%
2001	266	164	62%	105	64%	89	54%	52	32%
2002	273	159	58%	102	64%	83	52%	49	31%
2003	413	250	61%	164	66%	119	48%	72	29%
2004	561	339	60%	230	68%	149	44%	93	27%
2005	660	386	58%	272	70%	168	44%	100	26%
2006	788	469	60%	329	70%	193	41%	111	24%

Notes: Values in billions US $. Source Chinese Customs. Intermediates classified using the UN BEC classification. Firms are classified as intermediaries similarly to Ahn et al, 2010: if the name contains characters equivalent to "export", "import", "trade". The ommitted categories in OI are (i) capital and final good (by good column); (ii) non-SOEs (by ownership column); (iii) non-intermediaries (by trading type column).

Table A2. Intermediates Tariffs in 2000 and 2006 by Section — Summary Statistics

Section	Import Share (2006)	Mean		Median		SD		C.V.		Min		Max		Obs.
		2000	2006	2000	2006	2000	2006	2000	2006	2000	2006	2000	2006	
1 Animals	0.001	0.14	0.10	0.14	0.10	0.09	0.06	0.63	0.55	0.00	0.00	0.41	0.18	38
2 Vegetables	0.027	0.13	0.12	0.14	0.10	0.09	0.11	0.72	0.95	0.00	0.00	0.34	0.50	114
3 Fats & Oils	0.012	0.21	0.12	0.18	0.10	0.08	0.04	0.36	0.37	0.08	0.05	0.34	0.22	37
4 Prepared Foodstuffs	0.006	0.17	0.12	0.10	0.10	0.13	0.10	0.78	0.80	0.04	0.03	0.50	0.45	52
5 Minerals	0.308	0.04	0.03	0.04	0.03	0.02	0.02	0.60	0.70	0.00	0.00	0.09	0.08	146
6 Chemicals	0.126	0.09	0.06	0.09	0.05	0.04	0.03	0.42	0.48	0.02	0.00	0.41	0.24	707
7 Plastics, Rubber & Articles	0.065	0.14	0.09	0.15	0.08	0.04	0.03	0.26	0.36	0.03	0.01	0.34	0.22	184
8 Hides, Leather, & Articles	0.004	0.13	0.12	0.13	0.11	0.06	0.04	0.41	0.38	0.05	0.05	0.26	0.18	51
9 Wood, Straw & Articles	0.015	0.10	0.04	0.11	0.04	0.05	0.04	0.51	0.89	0.01	0.00	0.18	0.15	70
10 Pulp, Paper & Articles	0.024	0.13	0.05	0.14	0.07	0.07	0.03	0.57	0.55	0.00	0.00	0.37	0.07	120
11 Textiles & Articles	0.010	0.18	0.08	0.18	0.10	0.06	0.03	0.34	0.33	0.03	0.03	0.29	0.17	500
12 Footwear, Headgear, other	0.001	0.20	0.17	0.22	0.18	0.04	0.03	0.22	0.18	0.14	0.13	0.26	0.22	10
13 Stone, Plaster, Cement, other	0.005	0.16	0.12	0.15	0.11	0.06	0.05	0.38	0.40	0.08	0.00	0.37	0.25	133
14 Precious stones, Metals, Jewellery,...	0.004	0.06	0.04	0.03	0.01	0.09	0.05	1.41	1.39	0.00	0.00	0.34	0.19	29
15 Base Metals & Articles	0.104	0.09	0.06	0.10	0.06	0.04	0.03	0.46	0.55	0.01	0.00	0.26	0.26	491
16 Machinery; Elec. Equip.; Electronics	0.244	0.11	0.06	0.10	0.07	0.05	0.04	0.46	0.69	0.01	0.00	0.34	0.30	273
17 Vehicles, Aircraft, Vessels	0.033	0.19	0.08	0.22	0.09	0.12	0.06	0.65	0.67	0.02	0.00	0.53	0.26	43
18 Optical, Medical & other instruments	0.009	0.14	0.10	0.17	0.13	0.05	0.06	0.33	0.54	0.03	0.00	0.20	0.18	76
19 Arms and Ammunition	0.000	0.14	0.12	0.14	0.12	0.00	0.00	0.00	0.00	0.14	0.12	0.14	0.12	4
20 Miscellaneous Manufactures	0.002	0.20	0.14	0.20	0.18	0.03	0.07	0.13	0.47	0.10	0.00	0.22	0.22	34

Notes: Tariffs (ln) are 1 plus the Chinese statutory MFN tariff rates at the hs6-year level for UN BEC intermediates. Data sources described in Appendix B1.

Table A3. Initial Tariff Risk and Import Growth 2000-2006 (Δln) by Section — Summary Statistics

Section	Import Share (2006)	Mean		Median		SD		C.V.		Min		Max		Obs.
		Imports	Risk	Imports	Risk	Imports	Risk	Imports	Risk	Imports	Risk	Imports	Risk	
1 Animals	0.001	0.39	0.09	0.56	0.08	2.66	0.05	6.86	0.61	-5.90	0.00	6.84	0.19	38
2 Vegetables	0.027	1.17	0.08	1.11	0.07	2.46	0.06	2.11	0.80	-7.93	0.00	7.83	0.20	114
3 Fats & Oils	0.012	0.90	0.05	0.79	0.04	2.18	0.03	2.42	0.68	-2.05	0.01	6.54	0.13	37
4 Prepared Foodstuffs	0.006	0.52	0.07	1.16	0.06	2.52	0.03	4.83	0.50	-9.37	0.01	5.67	0.19	52
5 Minerals	0.308	1.69	0.07	1.41	0.06	2.13	0.05	1.26	0.77	-4.04	0.00	8.34	0.20	146
6 Chemicals	0.126	1.13	0.05	1.16	0.04	1.49	0.03	1.32	0.66	-5.15	0.00	8.66	0.31	707
7 Plastics, Rubber & Articles	0.065	1.32	0.06	1.41	0.05	1.26	0.03	0.96	0.48	-2.81	0.01	6.43	0.15	184
8 Hides, Leather, & Articles	0.004	1.85	0.10	1.62	0.10	1.65	0.05	0.89	0.57	-2.12	0.03	5.73	0.22	51
9 Wood, Straw & Articles	0.015	0.24	0.05	0.45	0.04	1.78	0.03	7.31	0.63	-2.91	0.00	6.19	0.12	70
10 Pulp, Paper & Articles	0.024	0.50	0.05	0.68	0.05	1.36	0.04	2.75	0.80	-3.13	0.00	4.92	0.19	120
11 Textiles & Articles	0.010	1.56	0.13	1.42	0.13	1.75	0.06	1.12	0.42	-3.34	0.00	8.90	0.24	500
12 Footwear, Headgear, other	0.001	2.12	0.22	2.50	0.22	1.59	0.04	0.75	0.18	-0.45	0.16	4.20	0.27	10
13 Stone, Plaster, Cement, other	0.005	0.93	0.09	1.07	0.08	1.26	0.04	1.35	0.48	-3.34	0.01	3.26	0.20	133
14 Precious stones, Metals, Jewellery,...	0.004	2.15	0.04	2.07	0.02	2.33	0.04	1.08	1.14	-3.27	0.00	9.73	0.12	29
15 Base Metals & Articles	0.104	1.53	0.05	1.44	0.03	1.72	0.05	1.12	1.01	-4.39	0.00	9.34	0.17	491
16 Machinery; Elec. Equip.; Electronics	0.244	0.98	0.05	1.20	0.04	1.34	0.04	1.36	0.81	-6.67	0.00	6.05	0.22	273
17 Vehicles, Aircraft, Vessels	0.033	1.35	0.05	1.86	0.03	1.63	0.04	1.21	0.82	-3.88	0.00	3.86	0.13	43
18 Optical, Medical & other instruments	0.009	1.08	0.08	1.34	0.09	1.71	0.06	1.58	0.69	-5.62	0.00	3.81	0.21	76
19 Arms and Ammunition	0.000	0.78	0.18	0.30	0.17	7.40	0.01	9.45	0.05	-6.01	0.17	8.66	0.19	4
20 Miscellaneous Manufactures	0.002	0.93	0.15	0.97	0.17	0.94	0.05	1.01	0.33	-1.76	0.06	2.81	0.24	34

Notes: Initial Tariff Risk is measured as ln (τ_{mean}/τ_t), where τmean is (1 plus) Chinese average MFN tariff rate during the pre-WTO period 1992-1999, and τt is (1 plus) Chinese MFN tariff rate in 2000. UN BEC intermediates. Imports are in log changes. Data sources described in Appendix B1.

Table A4. Manufacturing Firms Imported Intermediate Input Distribution (HS6)

		2000		2005	
		Firm #	Fraction Manuf. Firms (%)	Firm #	Fraction Manuf. Firms (%)
Intermediate Input Range	1	2,428	1.56	5,717	2.21
	2-10	6,630	4.26	14,429	5.58
	11-100	7,726	4.97	12,720	4.92
	101+	264	0.17	471	0.18
	Any	*17,063*	*11.0*	*33,337*	*12.9*

Notes: Source authors matching of Chinese Customs and Manufacturing Census data. Intermediates classified using the UN BEC classification. The total number of manufacturing firms in the denominator is 155,497 and 258,403 in 2000 and 2005.

Table A5. Firms' Imported Intermediate (HS-6) Statistics: Pre and Post; All and Continuing Firms

	Mean	Median	SD	Min	Max	N
I. All Importing Manufacturing Firms						
Pre	12.9	4	23.7	1	380	24,960
Post	12.8	4	22.4	1	453	107,591
II. Importing Manufacturing Firms in 2000 and 2005						
Pre	17.9	7	28.6	1	380	14,011
Post	19.5	8	27.9	1	453	41,670
III. All Importing Firms						
Pre	11.7	3	26.3	1	887	79,913
Post	11.0	3	24.2	1	973	332,498
IV. Importing Firms in 2000 and 2005						
Pre	18.3	7	34.2	1	887	33,230
Post	20.1	7	36.9	1	973	80,297

Notes: Source Chinese Customs for panels III, IV and match with Manufacturing Census data for remaining. Intermediates classified using the UN BEC classification. Years are 2000 and 2001 for pre and 2002-2006 for post.

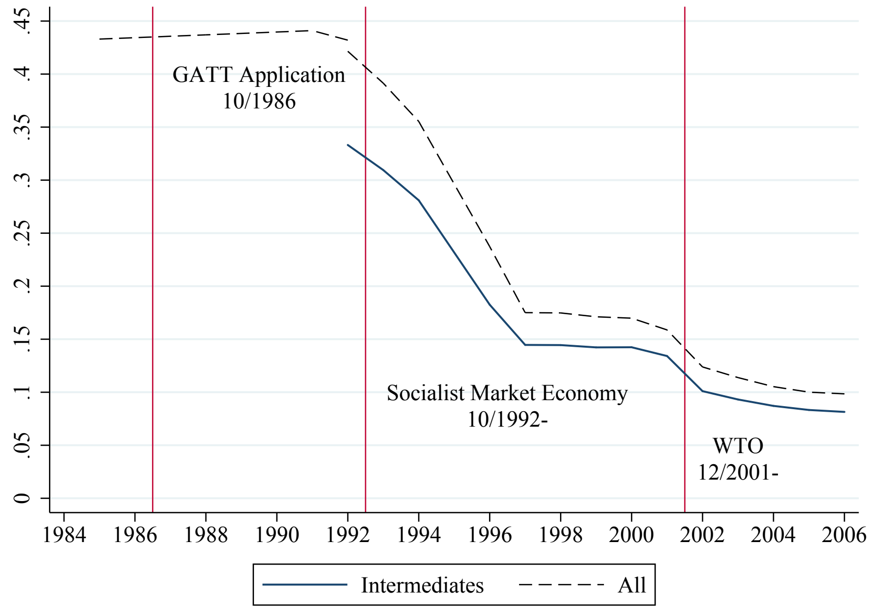
Table A6. Firm Intermediate Import Decision - Persistence

Dependent Variable = Firm-HS6 Import Indicator

Firm sample	All				Manufacturing			
	1	2	3	4	5	6	7	8
Lagged Import Indicator	0.130***	0.118***	0.130***	0.116***	0.176***	0.160***	0.176***	0.158***
	[0.00176]	[0.00148]	[0.00175]	[0.00148]	[0.00194]	[0.00159]	[0.00193]	[0.00160]
Fixed Effects	ft+s	ft+hs6	ft+st	ft+hs6-t	ft+s	ft+hs6	ft+st	ft+hs6-t
N	15,887,012	15,886,999	15,887,012	15,886,997	6,548,287	6,548,273	6,548,287	6,547,967
R^2	0.3	0.308	0.3	0.311	0.243	0.254	0.243	0.259

Notes: Dependent variable =1 if f-HS6 >0 at t, 0 otherwise for subsample of products f imported in at least one year. 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). Manufacturing firm subsample: those matched to production census.

Figure 1. China's Average Statutory Import Tariffs (1985-2006)



Notes. Simple average of MFN statutory rates over all products or intermediates (as defined by UN's Broad Economic Categories). Sources: Authors' calculations using UN TRAINS and WTO data for 1992-2006 (1995 interpolated); Lardy (2002, p. 34) for 1985, '88, '91, '92 (remaining interpolated). The Communist Party Congress discussed the Socialist Market Economy in 10/1992 and it became part of the Chinese constitution in 1993.

Figure 2. Varieties of Inputs

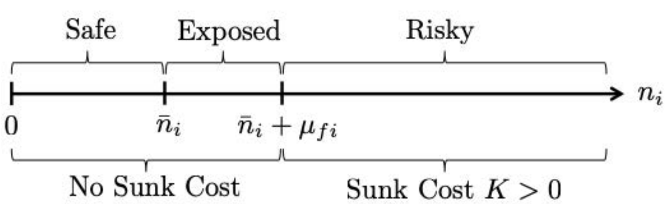
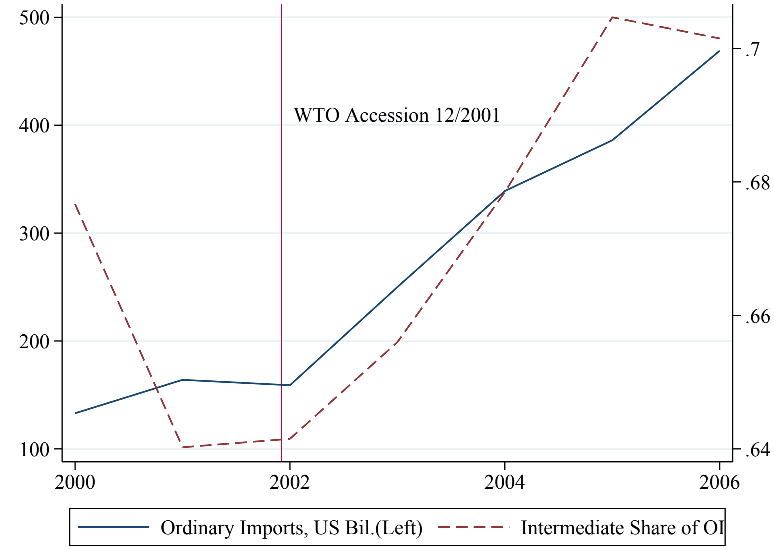
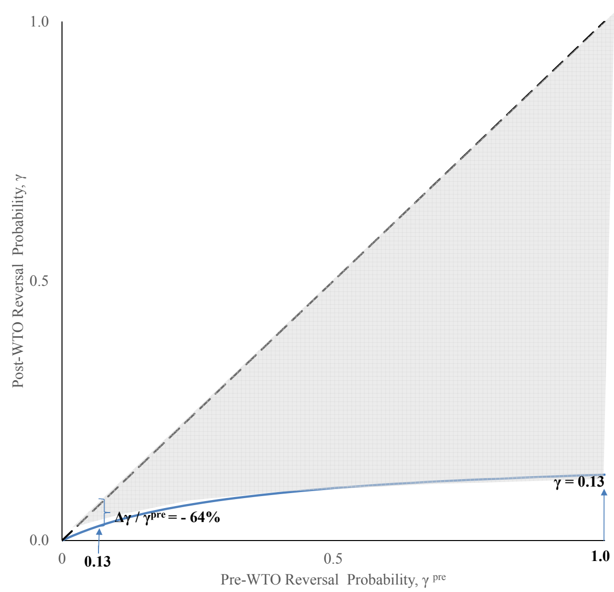


Figure 3. Chinese Ordinary Imports and Intermediate Share



Notes. Authors' calculations from Chinese Customs data. Ordinary imports (OI) identified by transaction identifiers; intermediate share uses UN BEC classification.

Figure 4. WTO Reduction in Uncertainty vs. Status Quo (Dashed)



Notes. Authors' calculations from baseline estimates assuming discount factor $\beta = 0.85$. See the text for further description.