Policy Uncertainty, Trade and Welfare: Theory and Evidence for China*

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ABSTRACT: We assess the impact of U.S. trade policy uncertainty (TPU) toward China in a tractable general equilibrium framework with heterogeneous firms. We show that increased policy uncertainty reduces investment in export entry and technology upgrading, which in turn reduces trade flows and real income for consumers. We apply the model to analyze China's export boom around its WTO accession and argue that in the case of the U.S. the most important policy effect was a reduction in TPU: granting permanent normal trade relationship status and thus ending the annual threat to revert to Smoot-Hawley tariff levels. We construct a theory-consistent measure of TPU and estimate that its elimination upon WTO accession explains about 30% of the observed Chinese export growth to the U.S. in 2000-2005—the equivalent of an *applied* tariff reduction of almost 7 percentage points. We also estimate a welfare cost of U.S. TPU for its consumers.

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1 Introduction

One of the most important economic developments in the last 20 years is China's global integration. The share of world imports from China rose from about 2% to 11% between 1990-2010. The share of U.S. imports from China in that period rose even faster: from 3% to 19%. More importantly, the U.S. share grew 1 percentage point per year on average in 2001-2010—twice the rate in 1990-2000. Recent evidence indicates that this export boom had large impacts—contributing to declines in U.S. prices (cf. Auer and Fischer, 2010), lower manufacturing employment and local wages (cf. Autor et al. Forthcoming). Some authors note the inflection year of the export growth to the U.S. coincides with China's WTO membership (December 2001) and argue that the accession may have reduced trade costs faced by Chinese exporters.[1] This argument is somewhat puzzling given that U.S. *applied* trade barriers toward China remained largely unchanged at the time of accession.[2]

We provide theoretical and empirical evidence that China's WTO accession did significantly contribute to its export boom to the U.S. by reducing the policy uncertainty faced by Chinese exporters. We also examine the impact this had on aggregate prices and welfare of consumers in the U.S.. China's WTO accession lead the U.S. to grant it *permanent* most favored nation (MFN) status, which ended the annual *threat* to impose prohibitive tariffs on Chinese goods. Although China never lost its MFN status since it was granted in 1980 it came close to it: after the Tiananmen square protests there was pressure to revoke the MFN status with Congress voting on such a bill every year in the 1990s and the House passing it three times. Had the status been revoked the U.S. would revert to Smoot Hawley tariff levels and a trade war would likely ensue. In 2000 for example, the average U.S. MFN tariff was 4% but if China had lost it MFN status it would face an average tariff of 35% with about one fifth of product tariff lines going up to at least 50%.

The potential impact of this policy uncertainty and the channel through which it affected trade was understood by policy makers and firms. For example, after President Clinton delinked the MFN status from China's domestic practices in 1994 the Hong Kong Secretary for Trade and Industry celebrated the U.S. decision stating that "It exceeds our expectations and businessmen and entrepreneurs can put their hearts at ease. This has removed a major issue of uncertainty and we can now go ahead with business plans in the normal way" and that the impact of renewal on investment and re-exports "(...) can only be evaluated retrospectively. But it will remove the threat of potential losses that would have arisen as a result

[1] Autor et al., Forthcoming make this point and also cite other motives for this export growth. China's share of world income been rising driven by internal reforms (many in the 1990s) with a subset of these being directly targeted towards the export sector, e.g. improved access to foreign technology & inputs (Hsieh and Klenow, 2009) and relaxed FDI rules (Bloningen and Ma, 2010).

[2] The main change in US trade barriers was the lifting of the textile quotas but this only occurred in 2005.

of revocation." But the uncertainty remained; in 1997 the Chinese Foreign Trade Minister urged the U.S. to abandon trade status reviews: "The question of MFN has long stymied the development of Sino-U.S. economic ties and trade (...) [It] has created a feeling of instability among the business communities of the two countries and has not been conducive to bilateral trade development". In 2002, after WTO accession, an official at the same Ministry pointed out that by establishing "the permanent normal trade relationship with China, [the U.S.] eliminated the major long-standing obstacle to the improvement of Sino-U.S. (...) economic relations and trade."[3]

The real effects on U.S. businesses activity and consumer welfare were also recognized. A coalition of businesses in the toy, apparel, footwear and electronics industries as well as exporters that feared retaliation lobbied Congress to make MFN permanent (Zeng, 2003). The CEO of Tyco Toys said "We view the imposition of conditions upon the renewal of MFN as virtually synonymous with outright revocation. Conditionality means uncertainty. We cannot plan and run our businesses if we are wondering whether our most important source of supply is about the disappear." Likewise, the American Association of Exporters and Importers wrote "Any annual review process introduces uncertainty, weakening the ability of U.S. traders and investors to make long run plans, and saddles U.S./China trade and investment with a risk factor cost not faced by our international competitors." [4] Reports prepared for Congress discussed the higher prices that consumers would face following revocation given the incidence of higher tariff rates (Pregelj, 2001).[5]

Our first question is: how do we identify and quantify the impact of U.S. trade policy uncertainty (TPU) on China's export boom? The answer has implications beyond this particular important event. It can inform us of the potential impacts of other sources of policy uncertainty, such as U.S. threats to impose tariffs against "currency manipulators" or not renew unilateral preferences to developing countries. More broadly, our results are relevant for understanding whether trade agreements promote trade. This is a central goal of the World Trade Organization (WTO), but its success is questioned by some (Rose, 2004) and supported by others (cf. Subramanian and Wei, 2007). By quantifying the role of trade agreements in reducing policy uncertainty, our work highlights how the WTO promotes trade through a channel that is largely missing from the empirical and theoretical debate, barring recent exceptions discussed below.[6]

[3] The news sources are respectively: "HK business leaders laud US decision" South China Morning Post, 5/28/94, Business section; "Minister urges USA to abandon trade status reviews" Xinhua news agency, 10/5/97, FE/D3044/G and "China-US trade volume increases 32 times in 23 years - Xinhua reports" BBC Summary of World Broadcasts, 2/18/2002.

[4] Both quotes appear on p.97 and p. 122 in "China Most-Favored-Nation (MNN) Status," Hearing before the Committee on Finance. U.S. Senate. June 6, 1996.

[5] A global general equilibrium study by Arce and Taylor (1997) estimated that if MFN were revoked, U.S. imports from China would decline by $11 billion with a welfare cost measured to real income of up to $1.8 billon.

[6] The WTO site for example states that "Just as important as freer trade – perhaps more important – are other principles of the WTO system. For example: non-discrimination, and making sure the conditions for trade are stable, predictable and transparent." (www.wto.org)

This leads to our second question: what are the aggregate price and welfare effects of trade policy uncertainty? The initial impetus is the doubling of Chinese import penetration in the U.S. between 2000-2005, which may have depressed aggregate prices and thus improved U.S. consumer welfare. The broader motivation is to contribute to the long standing question of the aggregate gains from trade. Recent work by Arkolakis et al. (2012) has focused on the gains from removing applied trade barriers. Our framework highlights and quantifies an additional source of welfare gains from trade reform: removing policy uncertainty. We will focus on consumer gains that arise from lower prices due to firm entry and technology upgrading investments, as discussed below.

Our theoretical approach captures the concerns of policy makers and business leaders with future policy by focusing on the interaction between uncertainty and irreversible investment decisions. When the cost of investment is sunk, this can create an option value of waiting that leads firms to delay investment until uncertainty is resolved or business conditions improve. The basic theoretical mechanism for this interaction is well understood (cf. Bernanke, 1983; Dixit, 1991) and there is some evidence that economic uncertainty, as proxied by stock market volatility, leads firms to delay investments (Bloom et al., 2007). In the international trade context, there is evidence of sunk costs to export market entry (cf. Roberts and Tybout, 1997) but most empirical research on its impact on export dynamics has focused on exchange rate uncertainty and found small or negligible impacts (IMF, 2010). Only a small body of research addresses the theoretical and empirical implications of economic policy uncertainty, in part because it is difficult to measure it and quantify its causal effects (Rodrik, 1991). Recent work by Baker et al. (2012) constructs a news-based index of policy uncertainty and finds it to predict declines in output and employment in VARs. In contrast, our approach uses applied policy and counter-factual policy measures, both of which observable, to directly estimate the effect on investment and economic activity in a structural framework.

In section 2 we develop a tractable dynamic heterogeneous firms model that we use to derive and then estimate the impacts of current and future trade policy on firms and consumers. In doing so we extend the partial equilibrium framework from Handley and Limão, 2012 (HL) in two important ways. First, we allow firms to make sunk cost investments to enter foreign markets (as in HL) *and* to upgrade their technology (to one with lower marginal cost). The model then predicts that reductions in TPU will generate new exports via both the extensive margin (as new firms invest to enter) *and* the intensive one: via endogenous technology upgrading by incumbent exporters. Allowing for upgrading is important for two reasons. First, entry may be insufficient to account for the large effects that TPU reductions can have (since new entrants are typically small) and second, there is evidence that *applied* tariff changes can trigger within firm productivity increases

(cf. Trefler, 2004, Lileeva and Trefler 2010).[7]

The second theoretical contribution is to examine TPU in a two-country general equilibrium context. In particular, we allow for export entry and upgrading to affect the importers's price index. This is motivated both by the sizeable increase in Chinese import penetration and our objective to examine its welfare impacts. We show that the general equilibrium price effects dampen the direct effect of TPU on entry and upgrading but do not eliminate it. Briefly, a TPU reduction generates an incentive to enter and upgrade but this then leads to a reduction in the price index (due to love of variety and lower costs respectively), which dampens the initial incentive. This price reduction is central in generating welfare gains from reforms that lower TPU in our model.

The model allows us to aggregate firm decisions to generate a tractable TPU-augmented gravity equation at the industry level. The model consistent TPU measure captures the proportion of profits lost that Chinese exporters expected before WTO accession if China ever lost its MFN status. Importantly, this pre-WTO uncertainty measure can be calculated by using observable MFN and column 2 tariffs. We then provide evidence that Chinese export growth in 2000-2005 was higher in those industries with higher initial uncertainty measure. Our identification approach is robust to industry specific unobserved heterogeneity as well as sector specific growth trends. We also control for a variety of changes in applied trade barriers, including tariffs and non-tariff barriers and transport costs.

We estimate the model's parameters and calculate the implied general equilibrium price effects. We find the uncertainty reduction lead to a 28 log point increase in Chinese exports to the U.S. in 2000-2005. The uncertainty effect explains about 30% of the observed export growth in that period and translates into an *applied* tariff equivalent of almost 7 percentage points.

We also compute the counterfactual decrease in the price index if China had lost its MFN status and find it is about 2% percent, which translates into a similarly valued reduction in real income for consumers that spend most income on differentiated goods. This places an upper bound on the potential cost of policy uncertainty in this model, which can be decomposed into a within state effect and a mean state switching effect. The latter captures the effect of starting at the MFN state and increasing the probability that the state will change for better or worse. It is positive if the expected welfare under MFN is higher than the average of the others. The within state effect on the other hand captures how uncertainty increases the price index due to lower entry and upgrading even when the policy state has not yet changed. We estimate the

[7] The contribution of intensive margin growth of surviving firms to total export growth is especially important for China. Manova and Zhang (2009) find that from 2003-2005, the share of export growth was 30% from entry, 42% from expansion at surviving firm-product-destinations, and 28% from surviving firm expansion into new products and destinations.

within state effect to be about 0.7 percent of welfare (for consumers that spend most income on differentiated goods). By comparison, Broda and Weinstein (2006) estimate that the total U.S. welfare gain from new varieties imported from all its partners is about 0.8 percent in the period of 1990-2001.

We also explore the entry predictions more directly to determine if there is any evidence of one of the channels highlighted by the theory. Since we do not have access to firm level data at this point we explore the product data at a more disaggregated level than the export analysis. More specifically, we examine the change in the number of traded products within each industry as a proxy for firm entry. We provide an identification condition that allows us to map variety (HS-10) growth to firm entry and when we explore it we find evidence of higher firm entry in industries with higher initial uncertainty. As the model would predict the impact of uncertainty on firm growth is stronger than on exports. In 2000-2005 we estimate that the uncertainty change lead to a 46 log point increase in Chinese exporters to the U.S., which is equivalent to the impact of an 11 percentage point reduction in applied tariffs.

As noted above we contribute to the recent literature on TPU by extending the partial equilibrium approach in HL to a setting with price effects and technology upgrading. Handley (2012) shows that reducing binding tariff commitments, a measure of the worst case tariffs, would increase entry of foreign products in Australia. Limão and Maggi (2013) endogenize policy uncertainty and provide conditions such that there is an uncertainty reducing motive for trade agreements in a standard general equilibrium model and derive a sufficient statistic for evaluating their welfare gains. By modelling and estimating the impact of TPU and providing evidence of its general equilibrium impacts we also contribute to the large and growing literature on the impact of Chinese import competition on wages and employment in the U.S. (cf. Autor et al., Forthcoming and Pierce and Schott, 2012) and the European Union (cf. Bloom et al, 2012).[8]

The paper is structured as follows. The following section presents the theory, starting with partial equilibrium firm decisions to export and upgrade technology and then extending this to incorporate general equilibrium effects. Section 3 describes the empirical approach and data and provides the estimates and quantification. We summarize the main results and implications in section 4. The theory and data appendices contain details related to the derivations, data and estimation.

[8] Pierce and Schott (2012) appeal to the theoretical TPU mechanism in Handley and Limão (2012) to use U.S. column 2 tariffs as a reduced form determinant of the impact of Chinese imports on U.S. manufacturing employment. However, in Handley and Limão (2012) there is no aggregate impact of TPU on the importer (the European Community) because the exporter is assumed to be small (Portugal). In contrast, the model and evidence in our current paper does include an impact of TPU on the importer via the price index and thus a channel via which the reduced form approach of Pierce and Schott (2012) can be justified.

2 Theory

Our model extends Handley and Limão (2012) in two directions mainly motivated by factors that are important to analyze China's export boom after WTO entry. First, we examine both a firms' initial entry decision to an export market *and* any subsequent technology upgrades, such that changes in uncertainty can also affect the exports of continuing firms. Second, given the relatively large size of Chinese exports, we examine the effect of changes in policy uncertainty on aggregate prices via the expansion of Chinese exports and the welfare impact on U.S. consumers. We first present the basic building blocks of the partial equilibrium version of the model and use it to analyze firm export entry and technology upgrading decisions. In section 2.4 we provide the remaining elements required for the general equilibrium model, which we use to re-examine the entry and upgrading decisions and to derive new results on the price index and consumer welfare.

2.1 Demand, Supply and Pricing

The utility function, $Q^{\mu}q_0^{1-\mu}$, is identical across consumers in all countries and defined over a numeraire good, denoted by 0, which is homogenous and freely traded on world markets, and a subutility index, Q, defined over differentiated goods with constant expenditure share μ. We consider a CES aggregator over a continuum of differentiated varieties, indexed by v, from the set Ω of available goods with an elasticity of substitution, $\sigma = 1/(1-\rho) > 1$

$$Q = \left[\int_{v\in\Omega} q_v^{\rho} dv\right]^{1/\rho} \tag{1}$$

Total expenditure on the differentiated good in a country is denoted by E and consumers face prices p_v so the aggregate demand for each variety v, q_v, is standard and given by

$$q_v = \frac{E}{P}\left(\frac{p_v}{P}\right)^{-\sigma} \tag{2}$$

where $P = \left[\int_{v\in\Omega} (p_v)^{1-\sigma}\, dv\right]^{1/(1-\sigma)}$ is the country's price index for the differentiated goods. Note that the income, price index and individual prices are specific to an importer country but in what follows we dispense with importer subscripts. The consumer price, p_v, includes any existing trade costs. In the theory we focus on ad valorem import tariffs and note that they are generally not firm specific but rather product or industry specific, so we denote the tariff factor that an importer sets on the group of varieties V by $\tau_V \geq 1$—free trade

is represented by $\tau_V = 1$. We will refer to different V as representing products or industries.[9] Therefore, producers of any variety v of product V receive p_v/τ_V where τ_V will be unity if v is produced and sold in the same country (i.e. we assume no domestic sales taxes). Firms pay an ad valorem cost, denoted d_V, that can include insurance, freight charges, labelling and other export costs.

We first determine the optimal price and operating profits for each monopolistically competitive firm conditional on supplying a market. For firms with a given technology, the marginal cost parameter, c_v, is constant and heterogenous across firms. Given a wage, w_e, in the exporting country e, the firms' marginal cost is then $w_e c_v$. In a deterministic setting the firm simply chooses prices (or quantities) to maximize operating profits in each period to each export market, $\pi_v = (p_v/\tau_V - w_e d_V c_v)\, q_v$, leading to the standard mark-up rule over cost, $\tilde{p}_v = w_e d_V c_v/\rho$, and the consumer faces this price augmented by any import tariff in that product.

$$p_v = (w_e d_V c_v/\rho)\, \tau_V \tag{3}$$

Firms make all *production* and *pricing* decisions after the policy and thus demand are known, so only its entry and upgrading investment decisions will be made under uncertainty. Substituting the demand function and markup rule into expression for operating profits we obtain

$$\pi_v = (\tau_V)^{-\sigma} c_v^{1-\sigma} d_V^{1-\sigma} A \tag{4}$$

where $A \equiv (1-\rho)\, E\, (w_e/P\rho)^{1-\sigma}$, summarizes aggregate conditions, e.g. domestic wage, w_e, and demand in a foreign market, which the firm takes as given. In section 2.4 we place additional structure on the model and examine how uncertainty can affect A. In particular we will be interested in the effects via the price index, P. To isolate this we pin down the wage by assuming the homogenous good is always produced in each country and uses only labor so the wage is simply the marginal product in that sector, which we normalize to unity. We then assume that the consumers of the differentiated good are workers who have no other source of income and thus expenditure on the differentiated is E is simply a fraction μ of the constant labor income.[10]

[9] To map this directly to the subutility index in (1) we can simply partition Ω into V sets and require identical elasticity of substitution across and within them to obtain $Q = \left[\Sigma_V \int_{v\in\Omega_V} q_v^\rho dv\right]^{1/\rho}$.

[10] As we will discuss in section 2.4, this requires that workers do not receive any policy revenue rebates or profits, which will go to entrepreneurs that own blueprints for each variety.

2.2 Policy Uncertainty and Firm Entry

Our focus is on firm decisions related to the export market. Thus, we take the mass of domestic differentiated good firms as given.[11] First, we consider the decision of a domestic producer to enter an export market. In the following section we include the possibility of investments in technology upgrading. In order to enter a new market a firms must incur a sunk cost, K_V.[12] A firm with production cost parameter c_v obtains operating profits from exporting equal to $\pi(a_{sV}, c_v) = a_{sV} c_v^{1-\sigma}$ where $a_{sV} \equiv A {\tau_{sV}}^{-\sigma} d_V^{1-\sigma}$ represents the conditions the firm in an industry V faces in the export destination under state s. We assume that export costs unrelated to tariff policy do not depend on the tariff state. Also, since A captures aggregate conditions it has no industry subscript. Note also that we will *initially* examine the decision of entry by firms in a "small" industry (e.g. a given HS 6 category, of which there are more than 5000) or in a set of industries that are "small". By this we mean that changes to policy in that industry V (or set of industries) has a negligible impact on the aggregate variables and so on A. In section 2.4 we show how the results extend to the case when policy shocks affect a large enough set of firms such that their export decisions affect aggregate conditions. Note that in the absence of aggregate effects, a firm in an industry V is also not affected by policy in other (small) industries. This allows us to consider the impact of policy changes industry by industry and to identify s for a given industry with the policy state for that industry.

There is a continuum of firms (in each industry) which differ only according to their cost. Therefore any given firm with cost at or below a given threshold, c_s, will enter the export market in state s. Thus we focus on determining that threshold both in the absence of uncertainty, as a benchmark, and then when there is uncertainty about the future state of market conditions, a_s.

Below we omit the industry subscript V to simplify the notation. If market conditions are at state s and are not expected to change, i.e. if there is no uncertainty, then the deterministic cutoff for entering a new export market, c_s^D, is defined by

$$\pi\left(a_s, c_s^D\right) / (1-\beta) = K \Leftrightarrow c_s^D = \left[\frac{a_s}{(1-\beta) K}\right]^{\frac{1}{\sigma-1}} \text{ for each } s \tag{5}$$

where operating profits are discounted by β, the probability that the firm will survive (there is no pure time discounting).[13]

[11] A simple way to rationalize this is the existence of a mass N of entrepreneurs that is constant each period. Each has one unit of specific capital (a blueprint for a variety with a production technology with marginal cost c_v). If there are no entry costs into the domestic market then there are always N varieties in the domestic market).

[12] There is evidence that these can be large. For now we do not take a strong stand on this, other than to assume that there are some fixed costs to export and that they are at least partially irreversible. We will return to this point later.

[13] Given the absence of fixed costs of exporting per period, the firm will continue to export until it is exogenously hit by a death shock. For a model with endogenous exit decision see Carballo, 2012.

When there is uncertainty about future conditions the firm will have to decide whether to invest today to enter the market or wait until conditions improve. At s a firm will be just indifferent if it has cost c_s^U , which is implicitly defined by the equality of the expected value of exporting, Π_e, given the current state net of the sunk cost and the expected value of waiting, Π_w.

$$\Pi_e(a_s, c_s^U) - K = \Pi_w(a_s, c_s^U) \text{ for each } s \tag{6}$$

Note that any firm in this industry with $c \leq c_s^U$ will export.[14]

We focus on policy uncertainty and therefore in order to determine the value functions and find the cutoffs we now describe the policy process.

We model the policy as a Markov process with transition matrix M, with elements $t_{ss'}$, representing a transition from s to s'. We do so in a way that captures some key features of the empirical application we subsequently explore: the U.S. policy towards China. Namely, starting in 1980 China was granted temporary MFN status by the U.S., which we denote by $s = m$. Thus, until 2001 a Chinese exporter in an industry V faced a tariff τ_{mV} but believed that the MFN status could be revoked in which case the U.S. would transition to a state $s = 2$ where it charged the much higher column 2 tariff, $\tau_{2V} > \tau_{mV}$. We denote the probability of this transition by t_{m2}. During the last part of that period, late 1990's and until 2001, China was negotiating entry into the WTO. We model this via a probability, t_{m0}, of transition from the temporary MFN status to entry into the WTO, which we denote $s = 0$. The latter state is characterized by a tariff $\tau_0 \leq \tau_m$ and a probability of column 2 that is lower than before ($t_{02} \leq t_{m2}$) or maybe even negligible ($t_{02} \to 0$). It is also reasonable to assume that if China faced column 2 tariffs then it would be less likely to transition to the WTO state directly then it would be the case if it were in a negotiation/MFN stage, i.e. $t_{20} \leq t_{m0}$, and in fact it would be extremely unlikely to go *directly* to that state from column 2 (so $t_{20} \to 0$).

In sum, we think that a reasonable characterization for this policy process requires:

1. 3 possible policy states: $s = 2, m, 0$, associated with column 2, temporary MFN and WTO policies where $\tau_{V2} > \tau_{Vm} \geq \tau_{V0}$ for each V.

2. the transition to either extreme state to be more likely if it occurs from the MFN state than from the other extreme, i.e. $t_{m2} \geq t_{02}$ and $t_{m0} \geq t_{20}$

[14] Note that if conditions were better in the past, i.e. if $c_{st}^U < \min_{T<t}\{c_{sT}^U\}$, then there are some firms that previously entered and have costs above the current cutoff. These legacy firms will still be in the market unless they have already been hit by an exogenous death shock. For now this has no consequence for our determination of c_s^U because changes in the number of firms in the market in any given (small) industry has no effect on aggregate conditions. But this will play a role when we consider general equilibrium effects.

In order to simplify the analysis we take the extreme case of (2) where $t_{02} = t_{20} = 0$. The period profit ordering across states for a given industry V is therefore $\pi_{2V} < \pi_{mV} \leq \pi_{0V}$. Then the *expected* value of exporting, denoted by Π_e, can be written as

$$\Pi_e(a_s, c) = \pi(a_s, c) + \beta \Sigma_{s'} t_{ss'} \Pi_e(a_{s'}, c) \quad \text{each } s \tag{7}$$

The key point to note is that if a firm is exporting at s and the policy persists into the next period then it faces the exact same policy *and* aggregate conditions (which will not be the case when we allow for general equilibrium effects). The expected value of exporting next period will equal the current value. For any given firm we have a linear system of three equations (one for each state) that can be solved for each $\Pi_e(a_s, c)$. Recalling our simplification that $t_{02} = t_{20} = 0$ it is simple to solve for $s \neq m$

$$\Pi_e(a_s, c) = \frac{\pi(a_s, c) + \beta t_{sm} \Pi_e(a_m, c)}{1 - \beta t_{ss}} \quad \text{each } s \neq m \tag{8}$$

Using this expression, (7) and simplifying we obtain the following for $s = m$

$$\Pi_e(a_m, c) = \frac{\pi(a_m, c)}{1 - \beta t_m} + \frac{\beta}{1 - \beta t_m} \Sigma_{s \neq m} t_{ms} \frac{\pi(a_s, c)}{1 - \beta t_{ss}} \tag{9}$$

where $t_m \equiv t_{mm} + \beta \left[t_{m0} \frac{t_{0m}}{1 - \beta t_{00}} + t_{m2} \frac{t_{2m}}{1 - \beta t_{22}} \right]$ reflects the probability that given a current state $s = m$ this state will be revisited the following period, t_{mm}, or in future periods if the firm survives (with probability β) and the policy goes to a different state, e.g. column 2 (with probability t_{m2}) and then returns to m (with probability $\frac{t_{2m}}{1 - \beta t_{22}}$).

If $s = 0$ then conditions can't improve further so the *expected* value of waiting is zero $\Pi_w(a_0, c) = 0$. The cutoff in this case is then implicitly given by

$$\frac{\pi(a_0, c_0^U) + \beta t_{0m} \Pi_e(a_m, c_0^U)}{1 - \beta t_{00}} = K$$

Any firm with $c > c_0^U$ will not enter at $s = 0$. Moreover, as we would expect and will later confirm, the cost cutoff under the agreement is the highest and the one under column 2 the lowest, i.e. $c_0^U > c_m^U > c_2^U$. So any firm with $c > c_0^U$ will also not enter in any other (worse) state. Note also that in the limit, if the agreement almost eliminates the possibility of returning to temporary MFN status (e.g. if exit from WTO is not expected) then $t_{0m} \to 0$ and $c_0^U = c_0^D = \left[a_0 / \left(1 - \beta \right) K \right]^{1/(\sigma - 1)}$.

We now find the values of waiting evaluated at the cutoff for each of the other two states. The expected

value of waiting for a firm at the worst state is

$$\Pi_w(a_2, c) = 0 + \beta \left[t_{22} \Pi_w(a_2, c) + t_{2m} \left[\Pi_e(a_m, c) - K \right] \right] \quad \text{if } c \in [c_2^U, c_m^U] \tag{10}$$

If it does not enter today it obtains zero profits and if it survives and nothing changes (which occurs with probability t_{22}) then it has the same expected value of waiting. Otherwise it faces a lower tariff, with probability t_{2m}, then it enters, provided that its cost is sufficiently low, i.e. $c \in [c_2^U, c_m^U]$. We do not consider transitions to state 0 since we assume $t_{20} = 0$.[15] We solve this expected value of waiting and replace in (6), which yields the cutoff for entry at column 2

$$\frac{\pi(a_2, c) + \beta t_{2m} \Pi_e(a_m, c_2^U)}{1 - \beta t_{22}} - K = \frac{\beta t_{2m} \left[\Pi_e(a_m, c_2^U) - K \right]}{1 - \beta t_{22}} \Leftrightarrow \frac{\pi(a_2, c_2^U)}{1 - \beta} = K \tag{11}$$

where we used $t_{2m} = 1 - t_{22}$. We see the cutoff is implicitly given by the equality of K and the present discounted value of profits *as if* the firm always expected to face a_2, therefore $c_2^U = c_2^D$. While firms are aware that conditions may improve that does not lead them to be more willing to enter than if conditions did not improve because they can simply wait and enter when conditions do change.

Finally, the value of waiting at $s = m$ is

$$\Pi_w(a_m, c) = 0 + \beta \left[t_{mm} \Pi_w(a_m, c) + t_{m2} \Pi_w(a_2, c) + t_{m0} \left[\Pi_e(a_0, c) - K \right] \right] \text{ if } \ c \in [c_m^U, c_0^U] \tag{12}$$

A firm decides to wait and not enter at MFN returns to the same situation if conditions do not change, $\Pi_w(a_m, c)$. If conditions worsen, it will continue to wait but at a higher tariff, $\Pi_w(a_2, c)$. Otherwise, if conditions improve and its cost is at or below the threshold at that point then it will enter.

We can provide a simple interpretation of the value of waiting by simplifying (12) using (10) and (8) evaluated at the threshold for entry at MFN along with (6) (see appendix section A.1 for derivation)

$$\Pi_w(a_m, c_m^U) = \frac{\beta t_{m0}}{1 - \beta \left(t_{mm} + t_{m2} \frac{\beta t_{2m}}{1 - \beta t_{22}} \right)} \left[\frac{\pi(a_0, c_m^U) + \beta t_{0m} \Pi_e(a_m, c_m^U)}{1 - \beta t_{00}} - K \right] \tag{13}$$

If the firm survives there is some probability that in the following period or a subsequent one the firm will transition from MFN to $s = 0$, pay the sunk cost and obtain the expected value of exporting.

[15] Note that we could ask what the value of waiting is for a firm if $c \in (c_m^U, c_0^U)$ but ultimately we are only interested in the value of waiting in worst case scenario evaluated for either the marginal firm in $s = 2$ or $s = m$ and neither of these will be higher than c_m^U.

Using the value of export in (9) and the value of waiting in (13), we can use the indifference condition in (6) to solve for the cutoff c_m^U.

After some simplification (in appendix section A.1) we obtain an expression for the cutoff that allows us to compare it directly to its deterministic counterpart

$$c_m^U = c_m^D U_m < c_m^D \tag{14}$$

where U_m reflects the effect of uncertainty in lowering the entry cutoff and is equal to

$$U_m = \left[\frac{1-\beta}{1-\beta\tilde{t}} \left(1 + \frac{\beta t_{m2}}{1-\beta t_{22}} \left(\frac{\tau_2}{\tau_m} \right)^{-\sigma} \right) \right]^{\frac{1}{\sigma-1}} \tag{15}$$

The term $\tilde{t} \equiv t_{mm} + t_{m0} + t_{m2}\frac{\beta t_{2m}}{1-\beta t_{22}}$ captures the probability that a firm enters in the future, either because it remains in MFN, moves to a better state, or moves to a worse state (t_{m2}) but eventually returns to MFN ($\frac{\beta t_{2m}}{1-\beta t_{22}}$). In the appendix section A.1 we show that $U_m < 1$ whenever $\tau_2 > \tau_m$ since the latter implies a reduction in profits of moving from τ_m to the higher tariff, τ_2. If firms believe conditions could improve, $t_{m0} > 0$, but there is no probability of a column 2 tariff , $t_{m2} = 0$, then we find the cutoff reaches its deterministic level, $c_m^U = c_m^D$, because $\tilde{t} = t_{mm} + t_{m0} = 1$. The result is analogous to what we found for the worst case cutoff scenario. The potential for good news is not relevant for the marginal entrant. In terms of the estimation, it implies that we can nest the possibility that firms believed that $t_{m2} = 0$ in our estimation.

In order to ask what the cutoff would have been in a world with more policy uncertainty when $s = m$, we parameterize policy persistence by γ and let $t_{mm} = 1-\gamma$, $t_{m2} = \gamma p$, and $t_{m0} = \gamma(1-p)$. An increase in γ lowers policy persistence in the MFN state. This increases uncertainty of remaining in that state, making it more likely that policy will go to *either* the worst *or* best case scenario. As we show in the appendix section A.1, the semi-elasticity of the cutoff with respect to γ is negative for all γ, indicating that increased uncertainty generates less entry independently of whether it improves or worsens outcomes.

$$\frac{d\ln c_m^U}{d\gamma} = \frac{d\ln U_m}{d\gamma} < 0$$

We also show that

$$\frac{d\ln U_m}{d\gamma}|_{\gamma=0} = \frac{\beta p}{(\sigma-1)(1-\beta t_{22})} \left(\left(\frac{\tau_2}{\tau_m} \right)^{-\sigma} - 1 \right) < 0$$

In the empirical work we will examine the impact of entering into WTO as a change from state m to

state 0. Therefore it is useful to note the ordering of the cutoffs we derived

$$c_2^U = c_2^D < c_m^U < c_m^D \leq c_0^D = c_0^U \tag{16}$$

We show this in detail in the appendix section A.1 but the ordering is reasonable: under uncertainty at the worst state, we have the lowest cost cutoff, c_2^U, so only the most efficient firms enter, under temporary MFN some additional firms enter and under a secure agreement (i.e. if no exit is anticipated) an even larger set of firms enters. The inequality $c_m^D \leq c_0^D$ is strict if $\tau_0 < \tau_m$ and the last equality assumes that the agreement state is an absorbing one ($t_{00} = 1$, so there is no uncertainty after it is entered).[16]

One final note on the importance of sunk costs for the results above. As long as there is some sunk cost, however small, the cutoff expressions, their ordering, and their elasticity with respect to applied policy and future policy remain unchanged. We can clearly see this since c_s^U is log separable in U_s, which is independent of K.[17] If there are no sunk costs, but the firm instead faces a period fixed cost, then the entry problem is simpler. Each period it exports if it has cost below a cutoff given by $\pi\left(a_s, c_s^f\right) = f$. In this case, policy uncertainty has no impact on entry decisions, since they are made after uncertainty about the relevant payoff (today's) is resolved. Even if small shipments to specific foreign buyers may take place by incurring a small period fixed cost, we would argue that sustaining mass exporting requires large sunk cost investments. Therefore we now extend the model to show how changes in policy uncertainty can lead firms to upgrade their export technology and thus affect the intensive margin of exports.

2.3 Policy Uncertainty and Firm Technology Upgrade

Given the magnitude of export growth from China, it seems plausible that not all of it was driven by new firms exporting to the U.S.. Therefore, we now model technology upgrade investments as a simple channel through which changes in policy uncertainty can generate new exports by incumbent firms. This extension is also of independent interest since the impact of trade reforms on within-firm productivity is one of general interest but has ignored the role of TPU

We allow firms the possibility of upgrading their export technology. More specifically, a firm can pay a sunk cost to adopt a lower marginal export cost technology. A simple way to illustrate the main points is to

[16] We can also show that $c_m^U \leq c_0^U$ even if $t_{0m} = 1$ (i.e. if a country exits the agreement after 1 period) and $\tau_0 = \tau_m$, simply because during the agreement period there is a zero probability of column 2.

[17] The elasticity of the number of firms with respect to policy is also independent of K under standard distributions such as Pareto, which we use later. In such cases variation in K would not provide useful variation in identifying the entry elasticity across industries for example.

focus on technology upgrades that are export market specific. We assume that if the firm has already paid the initial export entry cost, K, it can then decide to incur an additional K_z to lower its marginal export cost by a fraction $z < 1$ of the original value, d, which we recall is the variable trade cost component that is unrelated to tariffs.[18] Its period profits can therefore be written as $\pi\left(a_s, zc_{sz}^D\right) = a_s\left(zc_{sz}^D\right)^{1-\sigma} = A{\tau_s}^{-\sigma}d^{1-\sigma}\left(zc_{sz}^D\right)^{1-\sigma}$. So $z^{1-\sigma}-1$ is the growth in period operating profits due to the upgrade. Thus, if policy is deterministic, a firm with export cost d will be indifferent between upgrading or not if its marginal cost of production is c_{sz}^D, which is defined by $\pi\left(a_s, zc_{sz}^D\right) - \pi\left(a_s, c_{sz}^D\right) = K_z\left(1-\beta\right)$

$$c_{sz}^D = \left[\frac{a_s\left(z^{1-\sigma}-1\right)}{K_z\left(1-\beta\right)}\right]^{\frac{1}{\sigma-1}} \tag{17}$$

Depending on the upgrade technology we could have equilibria where the upgrading is done by all, none, or only a fraction of exporters. We focus on the latter case, which we find is the most interesting. This is also likely to be an empirically relevant case since it implies that only the most productive exporters upgrade, given that we assume there is a fixed cost so the most productive can spread it over more units. This also implies that the marginal entrant into exporting will not upgrade and therefore the entry cutoff, c_s^D, is still the one given by (5). Using this we can see that the upgrade cutoff is proportional to the entry cutoff, namely

$$c_{sz}^D = \phi c_s^D \tag{18}$$

where the upgrading parameter ϕ is given by

$$\phi \equiv \left[\left(z^{1-\sigma}-1\right)\frac{K}{K_z}\right]^{\frac{1}{\sigma-1}} < 1 \tag{19}$$

In sum, assuming that only a fraction of exporters upgrade then the entry cutoff is unchanged and higher than the upgrade cutoff. This is assured by the restriction that $\phi < 1$, i.e. that the marginal cost reduction is sufficiently high relative to the fixed costs. Note that ϕ is independent of the policy and therefore so is the *ratio* of cutoffs.[19] This simple extension magnifies the impact of policy since even small tariff reductions can generate large changes in exports due to upgrading from incumbent exporters. More importantly, and

[18] An interpretation of this advalorem export cost is that it represents some portion of the freight, insurance, labelling or meeting a product standard that is export specific and the firm can invest in a lower marginal cost technology to achieve these. To be more specific, we can think of different types of export entry. One alternative is for the firm to post a small advertisement or make a personal contact with a buyer at a fair and then ship some of the good directly to the buyer (so low fixed cost and high marginal cost of exporting). Another alternative is to pay a larger fixed (sunk) cost to establish a distribution network, have a marketing campaign, go through standard verification processes, etc, and then mass ship its products every period through a distributor that has lower marginal costs. Another interpretation is that a firm has a plant that produces only for exporting and it invests in production technology that is specific to that plant.

[19] In the empirical work we will allow it to vary across industries.

differently from others (cf. Bustos 2011), we will now see how policy uncertainty can affect exports for continuing exporters via upgrading.

We now determine the cutoffs under uncertainty when upgrading is possible. We will show that when only a fraction of exporters in each state upgrade then the ratio of the upgrade to the entry cutoff is ϕ, which is the same ratio found for the deterministic case. This implies that the elasticity of the upgrade and entry cutoffs with respect to policy and its uncertainty are the same—a result we will use in the aggregation and estimation. To simplify the exposition we focus on determining the upgrade cutoffs. Given the similarities with the entry decision we will simply point out how we must modify the setup to incorporate upgrading, state the results in the text and prove them in the Appendix section A.2.

We continue to assume that in any given state only a fraction of exporters upgrade so the marginal entrant in state s would not consider upgrading in *that* state. Moreover, if the upgrade parameter is sufficiently low then even the most productive marginal entrant would never upgrade, i.e. even a firm that is indifferent about entering under the worst policy state would never upgrade when conditions improved.[20] For ease of exposition we focus on the latter case since it allows us to use the entry cutoffs derived in the previous section. The reason why those entry cutoffs are still the relevant ones is simple, if the marginal entrants will never upgrade then their value of entry and waiting are not affected by the *possibility* of upgrading that is only done by others.

At a given state s a firm will be just indifferent between upgrading if it has cost c_{sz}^U , which is implicitly defined by the equality of the expected value of exporting using the upgraded technology net of the sunk cost and the expected value of waiting while using the old technology.

$$\Pi_e(a_s, zc_{sz}^U) - K_z = \Pi_w(a_s, c_{sz}^U, z) \text{ for each } s \tag{20}$$

Note that the upgrade factor z multiplies the cost in the expression of operating profits for each period after upgrading. Since z is state independent it is straightforward to show that the expected value of exporting under the new technology is given by the same general expression derived in 7, but replacing the marginal cost c with zc. This means that the value of exporting under upgrading is simply[21]

$$\Pi_e(a_s, zc_{sz}) = z^{1-\sigma}\Pi_e(a_s, c_{sz}) \text{ for each } s \tag{21}$$

[20] Formally, this requires $c_{0z}^U(\phi) < c_2^U$, where c_2^U is the entry cutoff under column 2 tariffs previously derived and $c_{0z}^U(\phi)$ is the upgrade cutoff under the best case (agreement) scenario that we derive below. In the appendix we provide the threshold value of ϕ below which this holds in terms of parameters.

[21] To see this replace c with zc in (9) and factor out z from the profit expressions. Then do the same in (8).

The value of waiting will also reflect the upgrade possibility but now must explicitly account for the profits before upgrading. This is why we write the value of waiting with z as a separate parameter—to clarify the difference in functional form relative to the initial formulation, which we wrote as $\Pi_w(a_s, c^U_{sz})$. To illustrate the difference consider the value of waiting at the MFN state

$$\Pi_w(a_m, c, z) = \pi(a_m, c) + \beta \left[t_{mm} \Pi_w(a_m, c, z) + t_{m2} \Pi_w(a_2, c, z) + t_{m0} \left[\Pi_e(a_0, zc) - K_z \right] \right] \text{ if } \; c \in [c^U_{mz}, c^U_{0z}] \tag{22}$$

The key differences relative to the value of waiting for entry in (12) are that now a firm that has not upgraded makes positive export profit $\pi(a_m, c)$ today. Moreover, in the following period the firm either transitions to the same state or to column 2 tariffs, in which case it still waits and thus uses the initial technology, or transitions to the agreement state, where it will upgrade.

In the appendix we derive $\Pi_w(a_2, c, z)$ and use that along with (21) in (22) to solve for $\Pi_w(a_m, c, z)$. We then use this and (21) along with the indifference condition in (20) to obtain the upgrade cutoff under MFN

$$c^U_{mz} = c^D_{mz} U_m \tag{23}$$

where c^D_{mz} is the deterministic cutoff in (17) and $U_m < 1$ is the same uncertainty factor we previously derived for entry in (15). Therefore we can write this in terms of the entry cutoff under uncertainty

$$c^U_{mz} = c^D_{mz} U_m = \phi c^D_m U_m = \phi c^U_m$$

This implies that the *elasticity* of either cutoff with respect to policy uncertainty factors in U_m is similar.

In the appendix we show that the relationship between the cutoffs in other states are similar, i.e. $c^U_{sz} = c^D_{sz} U_s$ for all s but, as seen before $U_2 = 1$ and, when $t_{00} - > 1$ we also have $U_0 - > 1$. So the ordering of cutoffs for upgrading across different states is the same as the ordering for entry in (16).

Entry into the agreement now has the additional effect of leading firms with $c \in (c^U_{mz}, c^U_{0z}]$ to upgrade. Therefore, reductions in uncertainty can lead not only to entry of new firms but also increases in exports by existing exporters that are sufficiently productive.[22]

[22] If the productivity distribution is unbounded then some firms will have upgraded in any state and so the new upgraders are exporters with intermediate productivity levels. If the distribution were bounded then it is possible that upgrading only takes place at the best state and by the most productive exporters.

2.4 Policy Uncertainty and Aggregate Effects

Thus far we focused on a situation where the impact of export entry and upgrading is too small to affect domestic aggregate variables. We now relax this assumption to determine the entry and upgrading decisions under general equilibrium effects. We will also examine the impact of policy uncertainty on consumer welfare via the price index. We will first examine the entry decisions and at the end of the section we will argue that the upgrade cutoffs are proportional to the entry ones, by the constant factor ϕ, as we show in the Appendix.

2.4.1 Setup

Recent work on China's export boom focuses on its costs for the U.S. (Autor et al., forthcoming; Pierce and Schott, 2013); we will instead focus on the potential benefits for consumers. More specifically, we examine the impact of reducing policy uncertainty on the price index. In order to do this we must place additional structure on the model and tackle two new issues.

First, tariff changes in industry V now have cross-industry effects through the price index. Therefore a potential exporter must form expectations not only about the tariff in its industry but also all others since these will affect the price index. This means that we must take a stand on the correlation of tariff shocks. Our assumption, which is consistent with our empirical application, is to continue to focus on a Markov transition matrix similar to what we had before, M, where now the transition applies to the full vector of tariffs, τ_s, and it is common knowledge.

Second, we must address the transition dynamics that affect aggregate variables. More specifically, we account for the fact that after a bad shock there is exit that occurs over time and thus the price index will also adjust over time as varieties die and are not replaced if their cost is above the cutoff. The adjustment will occur even in periods where no other policy shock occurs, as long as there are some firms still above the cutoff, which are exiting.
Therefore the economic conditions variable will in general have to be written as $a_{st} = (\tau_s)^{-\sigma} d^{1-\sigma} A_{st}$, which indicates the dependence on the policy state s directly via the tariff for that industry, and indirectly through the policy impacts on A_{st}.

The aggregate variable A_{st} depends on the exporting country's wage, the importer country's expenditure on differentiated goods, E_{st}, and its price index P_{st}. Note that we continue to assume that the numeraire good is freely traded and produced under a constant marginal product of labor equal to unity; this and the

assumption that the population is sufficiently large for the numeraire to always be produced in equilibrium implies that the wage is unity. In order to focus on the price effects of changing uncertainty and maintain tractability we construct the model to have constant expenditure on differentiated goods by making the following assumptions:

A1 There is no borrowing technology available across periods so current expenditures must equal current income each period for each individual.

A2 All individuals have similar labor endowments each period, equal to k_L. We assume there are two types agents: entrepreneurs and workers. A fraction of individuals are entrepreneurs with constant mass N. Entrepreneurs are endowed with a blueprint for a variety, embodied in the marginal cost parameter c_v. They receive any quasi-rents from that blueprint, i.e. the profits of variety v. Any import policy revenue is rebated lump-sum to the entrepreneurs. Given this, the only source of income for the other set of individuals, the workers, is the wage.

A3 Individual utility in each period exhibits a constant expenditure share, with a fraction on the differentiated that is $\mu > 0$ for workers and zero for entrepreneurs.

Note that A1,A2 and A3 along with the constant equilibrium wage and worker population imply that the total expenditure on the differentiated good in a country, E, is constant in all periods. Thus we will be able to focus on the impact of uncertainty on the price index.

The preference structure in A3 is also useful in directly mapping the firm problem we previously derived to the one solved by the entrepreneur. Assuming the entrepreneurs survive each period with probability β and are income risk neutral, their decision to use K_V units of labor (or equivalently the numeraire) to start exporting depends exactly on whether the expected value of doing so net of the entry cost exceeds the value of waiting, as previously given by (6).[23] One final point is that we rule out the possibility that entrepreneurs are credit constrained by assuming that their endowment $k_L \geq \max\{K_V\}$, so they can always self-finance the sunk cost in a single period even if it exceeds that period's operating profits.

The final simplifying assumption is that there are only 2 countries. This implies that any additional entry by exporters into a market does not affect the mass of firms from any other countries selling in that market since there is a fixed mass of domestic firms that always sells at home because there are no domestic fixed costs.[24]

[23] In making the entry decision the entreneurs take any lump-sum tariff rebates as given.

[24] In each period there is a constant mass N_V of entrepreneurs in each industry. Given no entry cost in the domestic market, there are always N_V domestic varieties in each V of the home market. An exogenous fraction $1-\beta$ of these dies at the end of each period but it is replaced at the start of the next so the mass N_V remains unchanged.

Given these assumptions we can then write the price index as a function of the foreign and domestic varieties

$$P_t^{1-\sigma} = \int_{v\in\Omega_t} (p_{vt})^{1-\sigma}\, dv = \int_{v\in\Omega_{t,ch}} (\tau_{Vt} d_V c_v/\rho)^{1-\sigma}\, dv + \int_{v\in\Omega_{us}} (c_v/\rho)^{1-\sigma}\, dv$$

Note that Ω_{us}—the domestic variety set available at any time t—is constant, for the reasons previously discussed, so the price index varies over time only because of the country's own import tariffs, reflected in τ_{Vt} and the current set of foreign varieties sold in the U.S. market, denoted by $\Omega_{t,ch}$. The latter set always includes foreign firms with cost below the cutoff but may also include legacy firms that entered when conditions were better in the past but would not enter today. So, whenever $c_{Vt}^U \geq \max\{c_{VT}^U\}$ for each V and all T so that entry conditions in the past were no better than today we can write the price index as a function of the vector of current tariffs and cutoffs $(\tau_t, \mathbf{c}_t)$.

$$P_t(\tau_t, \mathbf{c}_t) = \left[\Sigma_V N_V \int_0^{c_{Vt}^U} (\tau_{Vt} d_V c_v/\rho)^{1-\sigma}\, dG_V(c) + \int_{v\in\Omega_{us}} (c_v/\rho)^{1-\sigma}\, dv\right]^{\frac{1}{1-\sigma}} \tag{24}$$

In the presence of legacy firms, the price index will reflect previous cutoffs as we will subsequently discuss.[25]

Given these assumptions we can focus on the impact of policy uncertainty on firm decisions through its direct effect and the price index.

2.4.2 Deterministic policy

The deterministic policy entry cutoff is still defined by the expression in (5). However, this is now an implicit solution since P depends on the cutoff for this and all other industries. To gain insight into this effect consider starting in some state s, which is expected to persist indefinitely so the cutoff in any given industry is c_s^D. The associated price index can be written as a function of the state's tariff and cutoff vectors, $P_s^D = P\left(\tau_s, \mathbf{c}_s^D\right)$. One important point to note is that even though the countries may be asymmetric, the structure of the model implies that each country's price index depends only on its own policy and the cutoffs that determine which foreign firms sell domestically

The elasticity of entry with respect to tariffs now requires comparative statics on the system of $V+1$ equations that determine the foreign exporter entry cutoffs and the domestic price index. To verify that this system has a unique equilibrium we first make use of the fact that the cutoffs are linear in the price index

[25] The labor market clearing condition closes the model, but it only determines the allocation of labor to the numeraire sector. Since this will not affect the cutoffs and price index we do not include it here.

and in constant parameters. So any industry cutoff can be written as a linear function of some base industry cutoff, c_{sb}^D, and relative parameters, i.e. $c_{sV}^D = c_{sb}^D \kappa_{Vb}$ where $\kappa_{Vb} \equiv \left[\frac{(\tau_{sV}/\tau_{sb})^{-\sigma}}{K_V/K_b}\right]^{\frac{1}{\sigma-1}} \frac{d_V}{d_b}$. Using this we write the reduced form index as $P\left(\tau_s, c_{sb}^D, c_{sV\neq b}^D\left(c_{sb}^D \kappa_{Vb}\right)\right)$, which is a positive function that is continuous and non-increasing in c_{sb}^D (since $\partial P/\partial c_{sV}^D \leq 0$ for all V , strictly so for small enough c, and $\partial c_{sV}^D/\partial c_{sV}^D = \kappa_{Vb}$), as illustrated in figure 1.[26] Moreover, $c_{sb}^D|_{P\to 0} = 0$ and $\partial c_{sb}^D/\partial P > 0$. Therefore these two schedules intersect and do so only once as shown in figure 1.

Figure 2 illustrates the impact of an unexpected reform that lowers tariffs in all industries proportionally. We denote proportional changes in a variable by $\hat{x} \equiv d\ln x$ so we are considering $\hat{\tau}_V = \hat{\tau} < 0$ for all V. This implies that the relative cutoffs are unchanged. The entry schedule pivots down since for a given price index some firms in the base industry can now make a profit and enter. The price index schedule pivots down since for any cutoff the consumer prices are now lower. Thus it is clear that P falls. We can also show that the equilibrium operating profits and thus cutoffs for all industries increase as all the tariffs decrease proportionally. The latter result will be a useful benchmark in determining the worst case scenario for an industry when all policies change. To find the impact of a general change in tariffs (where $\hat{\tau}_V$ can vary across industries) we solve the following

$$\hat{P} = \Sigma_V \left(\varepsilon_{\tau_V} \hat{\tau}_V + \varepsilon_{_V} \hat{c}_V^D\right) \tag{25}$$

$$\hat{c}_V^D = -\frac{\sigma}{\sigma-1}\hat{\tau}_V + \hat{P} \quad \text{each } V \tag{26}$$

where $\varepsilon_{\tau_V} \equiv \frac{\partial \ln P\left(\tau, \mathbf{c}^D\right)}{\partial \ln \tau_V}$ and $\varepsilon_V \equiv \frac{\partial \ln P\left(\tau, \mathbf{c}^D\right)}{\partial \ln c_V}$ evaluated at the original tariff values. Replacing the cutoff we can solve

$$\hat{P} = \Sigma_V \left(\frac{\varepsilon_{\tau_V} - \frac{\sigma}{\sigma-1}\varepsilon_{_V}}{1 - \Sigma_V \varepsilon_{_V}}\right) \hat{\tau}_V \tag{27}$$

With a specific distribution such as Pareto, we can provide closed form solutions for ε_{τ_V} and $\varepsilon_{_V}$ as functions of σ, k_L and the share of imported differentiated goods at the initial tariff so that we can use (27) to provide a measure of gains from trade liberalization to workers, who are the sole consumers of the differentiated good. Given their Cobb-Douglas direct utility, the indirect utility is simply $\tilde{\mu} P^{-\mu}$ where $\tilde{\mu} = w k_L \mu^{\mu} (1-\mu)^{(1-\mu)}$ is constant since k_L is the period labor endowment and the wage $w = 1$ in the diversified equilibrium. Therefore the gain from the liberalization is simply $-\mu \hat{P}$, the proportional change in the price index weighted by the differentiated goods' share in expenditure.

Even without a specific productivity distribution we can show that the radial liberalization ($\hat{\tau}_V = \hat{\tau} < 0$)

[26] Continuity holds provided that the distribution of firms in each industry is not bounded above so there is always at least one active exporter.

increases the equilibrium cutoffs

$$\hat{c}_V^D|_{\hat{\tau}_V=\hat{\tau}} = \left(\Sigma_V \varepsilon_{\tau_V} - \frac{\sigma}{\sigma-1}\right) \frac{\hat{\tau}}{1-\Sigma_V \varepsilon_{_V}} > 0$$

where the inequality is due to $\varepsilon_{_V} \leq 0$ and $\Sigma_V \varepsilon_{\tau_V} < 1 \leq \frac{\sigma}{\sigma-1}$. We have $\Sigma_V \varepsilon_{\tau_V} \leq 1$ since the highest possible elasticity is if all goods (including domestic) were taxed at τ and the elasticity of P with respect to it would then be 1. One implication of this result is that all exporters will have higher profits after a liberalization that maintains relative tariffs unchanged.

Recall from section (2.2) that the tariff ordering in the setting we consider is $\tau_{V2} > \tau_{Vm} \geq \tau_{V0}$ for all V. In the absence of general equilibrium effects this ordering implied foreign exporter profits were lowest at column 2 and highest under the agreement. The result for the cutoff above shows that the same ordering would result if (in a deterministic setting) the tariff reductions from state 2 to m and then to 0 kept τ_{bs}/τ_{Vs} unchanged across states and for all V. We can also obtain the same ordering for each firm when the tariff change in an industry goes in the same direction as all the other industries and either (i) the changes are not too different across industries or (ii) the indirect price index effect is not too large.[27] For exposition purposes we will assume that either because of (i) or (ii) the direct tariff effect across states dominates the indirect one in the deterministic setting, $\pi\left(a_2^D\right) \leq \pi\left(a_m^D\right) \leq \pi\left(a_0^D\right)$, which requires

$$(\tau_{2V})^{-\sigma}\left(P_2^D\right)^{\sigma-1} \leq (\tau_{mV})^{-\sigma}\left(P_m^D\right)^{\sigma-1} \leq (\tau_{0V})^{-\sigma}\left(P_0^D\right)^{\sigma-1} \quad \text{each } V \tag{28}$$

This condition could be violated by a specific industry if its tariff across states are sufficiently close but in general it seems reasonable to assume that for most industries, as own tariffs fall this effect dominates, which implies that new exporters would enter. Moreover, in the empirical section we will provide some evidence that the indirect effect is generally smaller than the direct one.[28]

To gain some insight into the transition dynamics in this model (which we will require later) consider starting in a situation where the policy has always been at the worst case state, $s = 2$, and is expected to remain unchanged there so the cutoff is c_2^D in a given industry. If the tariff regime changes unexpectedly to $s = m$ then each industry faces lower tariffs, so as we illustrate in figure 2 the price index falls and the cutoffs increase. Since conditions improved all firms with costs at or below those cutoffs can immediately

[27] Using (27) and the definitions of the elasticity in the appendix we could provide specific conditions for this to hold, such as high enough trade costs for share of imported varieties in differentiated expenditure being sufficiently small.

[28] If the condition above fails for a particular industry then we would have to reorder the states in terms of profitability so that under column 2 some industries would be at their worst state and others would not, which would mainly complicate the aggregation.

enter, so the transition occurs in a single period.

Suppose instead that export conditions deteriorate from m to column 2. Now, firms with costs above the cutoff will continue to export (since they face no period fixed cost) until they are hit with a death shock. Therefore there are transition dynamics that can last several periods after conditions worsen. We can see the impact of this most simply in the case of an unanticipated shock, and later we will show how this same effect works in the case where there is ongoing policy uncertainty. Recall from previous sections that the *expression* for the cutoff at the worst case scenario under uncertainty is, in equilibrium, identical to the one under the deterministic formulation. We will see that is also the case here and thus we first derive the deterministic cutoffs in the transition period (as opposed to their steady state values derived above). Suppose that policy is expected to be fixed and starts at $s = m$, as represented by m^d in figure 3. Now consider an unexpected shock that shifts the tariff schedule to τ_2 and ask what the cutoff is. The shock shifts both the entry and price index schedules up as shown in figure 3 (in red) so the new steady state will be at 2^{ss}, with lower cutoff and higher P, which simply reverses the experiment in figure 2.

To understand the transition we use T to denote the time period since the negative tariff shock. *If* there was no death shock then after the tariff increase all of the firms would still be exporting and the price index would simply increase due to the direct tariff effect, as indicated by $m^{d'}$ in figure 3. However, given there is a death shock, the price index in the first period after the shock is higher than the value indicated by $m^{d'}$. During the transition the price index is a function of the current cutoff and the tariffs but it also reflects the initial equilibrium cutoff, $P_{2T}^D(\tau_2, \mathbf{c}_{2T}, \mathbf{c}_m)$, since some fraction of firms with costs between $\mathbf{c}_{2T}$ and $\mathbf{c}_m$ survive. Thus the current cutoff will be insufficient to pin down the price index during the transition and we will be off the steady state schedule in figure 3, $P_{2T\to\infty}^D(\tau_2, \mathbf{c}_{2T})$.

The entry *schedule* under the transition will be the same as the one derived under the steady state. To see this note that at some time T after the shock the firm must decide between entering the export market today or waiting. If it enters today it obtains $\Sigma_{t=T}^{\infty}\beta^{t-T}\pi(a_{2t}, c_{2t}^D)$ and if it waits then it obtains zero today but, if it is just indifferent between entering today or not, then in the following period it will enter and obtain a PDV of $\Sigma_{t=T+1}^{\infty}\beta^{t-T}\pi(a_{2t}, c_{2t}^D)$ because *after* the shock aggregate conditions will be improving (as other firms slowly exit). Therefore the firm that after the shock is indifferent between entering at T or not is the one where the *extra* profit from entering today relative to tomorrow, $\pi(a_{2T}, c_{2T}^D)$, is just enough to cover the extra cost paid today instead of next period $(1-\beta)K$. Equating these we obtain that after any period T the firm that is indifferent about entering when $s = 2$ must satisfy $\pi(a_{2T}, c_{2T}^D) = (1-\beta)K$. This cutoff can

be related to the "steady state" cutoff c_2^D in any given industry as follows

$$c_{2T}^D = \left[\frac{a_{2T}}{(1-\beta)K}\right]^{\frac{1}{\sigma-1}} = c_2^D \left[\frac{a_{2T}}{a_2}\right]^{\frac{1}{\sigma-1}} \tag{29}$$

Note that $\frac{a_{2T}}{a_2}$ is equal to the ratio of profits at T relative to steady state under $s = 2$. It is lower than unity as long as the price index at T, P_{2T}^D, is below its steady state, P_2. That will be the case, as argued above, since in the transition the firm faces more competition (from the firms that have not yet exited). The adjustment takes place as firms that die are not replaced and thus the price increases monotonically towards its steady state, so $P_{2T}^D \to P_2^D$. Thus, due to the exogenous death, after the unexpected shock from m to $s = 2$ the cutoff falls from c_m (point m^d) to c_{2T}^D (just right of 2^{tr}) and thus "overshoots" the steady state level (2^{ss}) . As firms exit the price level increases and the equilibrium cutoff moves along the new entry schedule from $c_{2T}^D \to c_2^D$.

2.4.3 Policy Uncertainty, firms, prices and welfare

We can now build on the deterministic case to analyze policy uncertainty. We develop the arguments in the basic setting and then discuss its extension to allow for upgrading. Our approach will be the following. First, we will relate the worst (column 2) and best (WTO agreement) scenarios to the deterministic counterparts. Second, we will derive the impact of policy uncertainty under the MFN state on firm decisions, the price index and consumer welfare.

In general there could be transition dynamics whenever a shock leads to worse conditions. This would occur if the country went to $s = 2$, as described above. This could also occur if a country entered the agreement ($s = 0$) and then exited back to $s = m$. In order to simplify the analysis we will focus on the case where the probability of exiting the agreement state, t_{0m}, is zero and also assume that the economy starts at m. This has two implications. First, there is a single entry cutoff value per industry for $s = 0, m$, which is time independent conditional on the state. Second, the entry cutoff for $s = 0$ is given by the deterministic expression in (5) since $t_{02} = 0$, but now takes into account the price index effect, which we discussed above. Therefore, the agreement equilibrium would simply be a point such as 0 in figure 4 with the entry and price index schedules derived in the previous subsection and evaluated at τ_0. Given this, we simply need to determine c_{2T}^U and c_m^U. Since the approach to determine these cutoffs is similar to that in section (2.2), we will describe the main results and provide the details in the appendix.

First, the worst case cutoff schedules under uncertainty are identical to the deterministic ones in (29).

The argument is similar to the one made in the deterministic case: after T periods of moving to $s = 2$ a firm that is indifferent between entering at T or waiting will surely enter at $T + 1$ if it survives. The reason is that conditions will improve with certainty either because the tariff state improves or because the aggregate conditions improve. Thus a firm is indifferent if $\Pi_e(a_{2T}, c) - K = \Pi_w(a_{2T}, c^U_{2T})$, which we show in the appendix yields exactly $\pi(a_{2T}, c) = (1 - \beta) K$ and therefore $c^U_{2T} = c^D_{2T}$. The functional form for the price index after T periods of switching to column 2 would also be similar to the one we described in the deterministic case and can be written as $P_{2T}\left(\tau_2, \mathbf{c}_{2T}, \mathbf{c}^U_m\right)$, but the initial starting value for the cutoff would now be $\mathbf{c}^U_m$, which we will show is different from the deterministic value. But conditional on this starting value, the path after the shock will be the one illustrated by 2^{tr} towards 2^{ss} (where the latter may never be reached since eventually a shock will lead back to MFN).

As we noted before since we start at $s = m$ and there is no possibility of exiting the agreement, this implies that whenever at $s = m$ there is no history of better conditions and thus there are no transition dynamics due to exit of firms above the threshold (there is exit below the threshold due to death each period but it is immediately offset by entry so the price index is unchanged). Therefore we need only determine a single cutoff per industry for this state. To do so, note that the functional form for the expected value of export is the same as in the baseline (7) and that is also the case for the value of waiting, given by (12). The difference is that now the expressions for the expected values of export and waiting under $s = 2$ are different due to the transition dynamics. More specifically, we must solve for the value of exporting and waiting in the period after a column 2 shock, i.e. $\Pi_e(a_{2T=0}, c)$ and $\Pi_w(a_{2T=0}, c^U_m)$. After doing so we again employ the indifference condition in (6) for the MFN state to derive c^U_m and relate it to the deterministic cutoff as follows

$$c^U_m = \left[\frac{a_m}{(1-\beta) K}\right]^{\frac{1}{\sigma-1}} U_m(\tilde{\omega}) = c^D_m \frac{P_m}{P^D_m} U_m(\tilde{\omega}) \tag{30}$$

where

$$U_m(\tilde{\omega}, t_{ss'}) = \left[\frac{1-\beta}{1-\beta\tilde{t}}\left(1 + \frac{\beta t_{m2}}{1-\beta t_{22}}\tilde{\omega}\right)\right]^{\frac{1}{\sigma-1}} \tag{31}$$

Note that $U_m(\tilde{\omega})$ is similar to the one we derived in the absence of general equilibrium effects (15) differing only in the term capturing the proportion of profits lost. That term is now $\tilde{\omega} = \left(\frac{\tau_2}{\tau_m}\right)^{-\sigma} g$, which still reflects the ratio of the PDV of profits under the worst case scenario relative to state m, but now takes into account $g \equiv \frac{(1-\beta t_{22})\Sigma_{t=0}^{\infty}(\beta t_{22})^t A_{2t}}{A_m} \geq 1$. This effect captures the average business conditions (other than tariffs) after a transition to column 2 tariffs relative to the conditions under MFN, A_m, and is common to all industries. Note that in the absence of uncertainty about staying in the MFN state ($t_{mm} = 1$ so $t_{m2} = 0$) we have

$U_m(\tilde{\omega}) = 1$ and otherwise it is less than 1 since $\tilde{\omega} < 1$ whenever the direct effect dominates, as we show in Appendix A.3.

The additional difference between the uncertainty and deterministic cutoff in the presence of price effects is captured by the difference in the price index due to uncertainty. This arises because c_m^D is evaluated at P_m^D but under uncertainty, the price index will generally be higher due to less entry, as we argue below. Therefore, all else equal the general equilibrium effects partially offset the direct impact of uncertainty on entry. Whenever the general equilibrium effect of the agreement on the price index is sufficiently small (so $\frac{P_m}{P_m^D} \longrightarrow 1$) we have $c_m^U(\tilde{\omega}) < c_m^D$ due to $U_m(\tilde{\omega}) < 1$.

To analyze the impact of uncertainty when the price effects are not negligible we again write $t_{mm} = 1-\gamma$ and $t_{m2} = \gamma p$ and $t_{m0} = \gamma(1-p)$ so an increase in γ lowers policy persistence in the MFN state. Note that if we start at m and there is no uncertainty, $\gamma = 0$, then $U_m(\tilde{\omega})\frac{P_m}{P_m^D} = 1$ and we obtain the deterministic cutoff and price index equilibrium. We showed the existence and uniqueness of such an equilibrium and will thus examine the impact of uncertainty around it. Note that the only *direct* effect of γ on the economy occurs through $U_m(\tilde{\omega})$ and so we will first derive this effect. As we can see from the definition of $U_m(\tilde{\omega})$, holding $\tilde{\omega} = \left(\frac{\tau_2}{\tau_m}\right)^{-\sigma} g$ fixed the parameter γ affects U through $\tilde{t}$ and t_{m2}. In general, those changes in γ will affect current conditions and therefore they would affect the future price path reflected in g. However, those indirect general equilibrium effects through g are multiplied by γ and so they disappear when we evaluate around $\gamma = 0$. Given this, the total impact around $\gamma = 0$ can be derived separately from the indirect effects on the cutoffs and price index and is equal to

$$\frac{d\ln U_m(\tilde{\omega}_V, t_{ss'})}{d\gamma}|_{\gamma=0} = \frac{\beta p}{(\sigma-1)(1-\beta t_{22})}(\tilde{\omega}_V|_{\gamma=0} - 1) \quad \text{each } V \tag{32}$$

where the g term in $\tilde{\omega}_V|_{\gamma=0}$ is evaluated at the deterministic values P_m^D and P_{2T}^D previously derived.

Using this result we can compare the deterministic cutoff and prices with those where $\gamma > 0$.[29] The price index starting at $s = m$ can be written as a function of the cutoffs, $P_m(\tau_m, \mathbf{c}_m)$. From (30) we have $c_{mV}^U(U_m(\tilde{\omega}_V), P_m, \tau_{mV})$ and note that it is log linear in each of those arguments to obtain

$$\frac{d\ln c_{mV}^U}{d\gamma}|_{\gamma=0} = \frac{d\ln U_{mV}}{d\gamma}|_{\gamma=0} + \frac{d\ln P_m}{d\gamma}|_{\gamma=0} \qquad \text{each } V \tag{33}$$

$$\frac{d\ln P_m}{d\gamma}|_{\gamma=0} = \Sigma_V \varepsilon_V \frac{d\ln c_{mV}^U}{d\gamma}|_{\gamma=0} \tag{34}$$

[29] In addition to comparing these values, across γ we could also examine the transition dynamics similarly to what we did for the tariff increase. The increase in uncertainty would not lead all firms above the cutoff to exit initially but would do so over time so the price index would be increasing over that path.

The first term in the cutoff expression is the direct effect of policy uncertainty on an industry, which is similar to the one without price effects but now evaluated at $\tilde{\omega}$. As we noted before this direct effect lowers the cutoff. The second term is the indirect effect through the price index, which is positive if uncertainty lowers a weighted average of the cutoffs and thus increases the price index. The relevant weight is the elasticity of the price index with respect to each industry cutoff, $\varepsilon_V \equiv \frac{\partial \ln P(\mathbf{c}_m)}{\partial \ln c_V}$ evaluated at the deterministic value. We can verify that uncertainty increases the price index by solving the system to obtain

$$\frac{d \ln P_m}{d\gamma}|_{\gamma=0} = \frac{\beta p}{(\sigma-1)(1-\beta t_{22})} \Sigma_V \tilde{\varepsilon}_V \left(\tilde{\omega}_V - 1\right)|_{\gamma=0} > 0 \tag{35}$$

where $\tilde{\varepsilon}_V \equiv \frac{\varepsilon_V}{(1-\Sigma_V \varepsilon_V)}$. The inequality is due to $\varepsilon_V < 0$ (shown in appendix section A.5) and $\tilde{\omega}_V < 1$ for each industry (where the latter holds whenever the direct effect dominates as required in (28)). A weaker necessary and sufficient condition for uncertainty to increase the price index is for the import weighted measure of $\tilde{\omega}_V - 1$ to be negative, as we show in the appendix. The general equilibrium effect due to reduced competition is common to all industries and partially offsets the direct effect. In our estimation, we will control for it and estimate the direct effect, which is an overestimate of the total effect of uncertainty on entry. We will then employ the estimated parameters and data to provide an estimate of the price elasticity with respect to γ that we can use to bound the general equilibrium effect of uncertainty on the cutoff and thus on entry and trade flows.

We compare the outcome under uncertainty to the deterministic ones in figure 4. Point m^d represents the deterministic cutoff at τ_m and point m represents the higher price index and lower cutoff in the base industry due to uncertainty. If the agreement simply eliminates uncertainty then it moves the economy from m to m^d. If in addition to eliminating uncertainty the agreement also reduces tariffs then the new equilibrium is at point 0.

The price index effect is interesting in its own right since it is central to the welfare impact of uncertainty on consumers, as we now show. Recall that the indirect utility for workers in any given period when the state $s = m$ is simply $\tilde{\mu} P_m^{-\mu}$ where $\tilde{\mu}$ is constant. Moreover, we assume that consumers are income risk neutral so we can represent the expected welfare for these consumers starting at the uncertain MFN state as

$$W_m = \tilde{\mu} P_m^{-\mu} + \tilde{\beta} \left[t_{m0} W_0 + t_{m2} W_{2m} + t_{mm} W_m \right]$$

where W_0 and W_{2m} are respectively the expected value of welfare under the agreement and under column 2 (after a transition from $s = m$) and $\tilde{\beta} < 1$ is the discount factor used by consumers, capturing their

probability of survival, which may or may not be the same as that of entrepreneurs. Using $t_{m2} = \gamma p$ and $t_{m0} = \gamma (1-p)$ we can then derive the semi-elasticity of individual expected welfare with respect to γ around $\gamma = 0$ as

$$\frac{d \ln W_m}{d\gamma}|_{\gamma=0} = -\mu \frac{d \ln P_m}{d\gamma}|_{\gamma=0} - \frac{\tilde{\beta}}{1-\tilde{\beta}} \left(\frac{W_m - (1-p) W_0 - p W_{2m}}{W_m} \right) |_{\gamma=0}. \tag{36}$$

The first term captures the negative impact of increased uncertainty in a state on consumer welfare in that state due to lower firm entry and the resulting higher price index, as explained above. Therefore we label the term $-\mu \frac{d \ln P_m}{d\gamma}|_{\gamma=0}$ the "*within state welfare effect*" of policy uncertainty. The second term captures the "*mean state switching welfare effect*" of policy uncertainty. If at MFN a policy shock becomes more likely then the probability of switching to either of the other states is higher and expected welfare would decrease if in the deterministic setting W_m is higher than the average in the other states, $(1-p) W_0 + p W_{2m}$. The latter case is plausible in the setting that we will consider where the applied tariffs did not change much between the MFN and the agreement states. In Appendix section A.5.4 we derive expressions for both effects. In the quantification section we discuss how our estimates allow us to quantify the within state welfare effect.[30]

In sum, thus far in this section we showed that:

1. The basic approach can be extended to incorporate general equilibrium effects arising from the impact of the extensive margin.

2. We can still estimate a direct or partial effect of uncertainty in industry V on entry in that industry. But this partial effect overestimates the total effect of a reduction in uncertainty in the presence of general equilibrium effects, particularly if uncertainty is reduced for all industries simultaneously. We will employ (33) to adjust for those effects in the quantification This will use the price elasticities, ε_V, which we show in the appendix, can be derived as a function of data and parameters to be estimated.

3. Increased policy uncertainty has a negative within state welfare effect on consumers, via higher price index due to lower foreign entry, and possibly also a negative effect if it leads to switching to worse states on average.[31]

The final step is to allow for upgrading in this setting. In section 2.3 we showed that the upgrade cutoff was lower than the entry cutoff by a fixed technology parameter, i.e. $c^U_{sz} = \phi c^U_s$. A similar result holds when there are price effects. This can be shown by allowing for the possibility to upgrade and imposing a large enough cost to do so such that the marginal *entrant* in any state does not upgrade (i.e. $c^U_{z0} < c^U_{2T=0}$). In

[30] Note that we are not analyzing welfare during the transition period where γ increases but rather capturing the change in welfare that we would have in a deterministic situation vs. one where the economy started with some positive uncertainty. We do not need to solve explicitly for the values of W_0 and W_{2m} under uncertainty because the impact of γ on either of these is multiplied by γ evaluated at zero so their effect disappears.

[31] Part of the consumer loss is offset by the higher sales and thus profits earned by domestic entrepreneurs in the importer country due to the higher price index.

that situation, the entry cutoff (implicit) expressions are the same we derived above, e.g. (30).[32] Given this result, we can apply the approach in section 2.3 to show that the ratio of the upgrade to the entry cutoff is simply the fixed upgrade parameter, e.g. $c_{mz}^U = \phi c_m^U$, where c_m^U and ϕ are respectively given by (30) and (19). We show this explicitly in the appendix A.4.

It is also possible to derive the general equilibrium effects of uncertainty under upgrading. The approach would be similar to the one we used above. The expression in (33) would still hold but the price term $\left(d \ln P_m \left(\mathbf{c}_m^U, \mathbf{c}_{mz}^U\right)/d\gamma\right)$ would now include effects from entry and upgrade. To obtain the total effect of uncertainty we now need to solve the system that includes the two types of cutoff in each industry and the price index. In the appendix we show that increases in uncertainty will increase the price index both by reducing entry and upgrading. Moreover, since $c_{mz}^U = \phi c_m^U$, the expression for the price index semi-elasticity with respect to γ will be similar to the one derived without upgrading in eq.(35) but the equilibrium value of $\tilde{\varepsilon}_V$ and $\tilde{\omega}_V$ will be different since it will reflect trade flows and the price level with upgrading.

2.5 Policy uncertainty and exports

We now examine how changes in policy uncertainty translate into export growth. We also show how to derive a tractable estimation equation.

The export revenue received by a given firm at time t in an industry V is $p_{tv}q_{tv}/\tau_{tV}$. When we aggregate firm sales over the (endogenous) set of export firms at t (Ω_{tV}) we obtain the industry export value. When upgrading is possible there is a subset of firms that upgrades (Ω_{tV}^z) and has costs zc_v lower than the remaining set of firms ($\Omega_{tV} \setminus \Omega_{tV}^z$). Using the optimal price and quantity derived before and the economic conditions variable a we obtain

$$R_{tV} = a_{tV}\sigma \left[\int_{v \in \Omega_{tV}^z} (z_V c_v)^{1-\sigma} \, dv + \int_{v \in \Omega_{tV} \setminus \Omega_{tV}^z} (c_v)^{1-\sigma} \, dv \right] \tag{37}$$

For a given mass of firms that export and upgrade, exports can only grow if current economic conditions improve, i.e. if a_{tV} increases, which requires changes in the applied policy for example, but does *not* depend on policy uncertainty.[33] Therefore in this model, policy uncertainty affects exports only through its effect on the mass of firms that enter into exporting or upgrade their technology. For a given level of current conditions, a_{tV}, we can see that increases in the mass of exporters or upgrading firms raises the term in

[32] The entry cutoff *equilibrium* values will be different since the price index will now reflect lower prices by firms that upgrade, but as long as the ordering of profits in 28 still holds when evaluated at the new price index, the entry cutoff expressions will be unchanged. Note also that 28 implies the same ranking of profits for the firm if it upgrades its technology.

[33] We take the technology parameter z_V as a fixed parameter.

parenthesis and thus raises exports. Moreover, this mass is increasing in the fraction of foreign firms that decide to export, i.e. the fraction with costs below the entry cutoff we derived previously, c_{tv}^U. So, for given a_{tV}, reductions in uncertainty, which increase c_{tv}^U, as seen in the previous sections, will increase the mass of exporters and upgraders, and thus exports.

We could employ (37) and the cutoff expressions derived to examine the first order effects of alternative variables. However, we explore the structure of the model by assuming a specific productivity distribution to obtain sharper predictions, nest a standard gravity model in our framework, and provide precise conditions under which we can identify the impact of uncertainty on exports. Since our data will apply to what we model as states $s = 0$ and m, our derivation below focuses on these. Recall that conditions can't improve beyond the agreement state so when $s = 0$ the mass of exporting firms is equal to $N_V G\left(c_0^U\right)$, the product of all producers in industry V in the export country times the fraction with costs below the cutoff (G is the CDF of costs). The mass of exporters under the temporary MFN state, $s = m$, is also equal to the fraction of exporters with costs below the relevant threshold, $N_V G\left(c_m^U\right)$, if policy conditions were never better, i.e. if there was never an agreement in the past, which applies to China's situation.[34] A sufficient condition in the context of the model for $N_V G\left(c_m^U\right)$ to exactly capture the mass in this state is for the agreement to be an absorbing state, $t_{00} = 1$, so there is no exit from the agreement. In this case we can write exports for either $t = 0, m$ as

$$R_{tV} = a_{tV}\sigma N_V \left[\int_0^{\phi c_t^U} \left(z_V c_v\right)^{1-\sigma} dG_V(c) + \int_{\phi c_t^U}^{c_t^U} \left(c_v\right)^{1-\sigma} dG_V(c)\right] \quad \text{for } t = 0, m \tag{38}$$

where we used the relationship between the upgrade and entry cutoff previously derived.

If we also assume the productivity has a Pareto distribution that is bounded below at $1/c_V$ but unbounded above then $G_V(c) = (\frac{c}{c_V})^k$. Using this and assuming $k > \sigma - 1$ we can integrate the cost terms and simplify to obtain

$$R_{tV} = a_{tV}(c_{tV}^U)^{k-\sigma+1}\zeta_V \alpha_V$$

where the industry specific parameters reflecting distribution and upgrading factors are respectively $\alpha_V \equiv \frac{N_V \sigma}{c_V^k}\frac{k}{k-\sigma+1}$ and $\zeta_V \equiv 1 + (\phi_V)^{1-\sigma+k}\left(z_V^{1-\sigma} - 1\right) > 1$. In order to compare to standard gravity equations we take logs, use the definition of a_{tV}, the entry cutoff result $c_{tV}^U = \left[\frac{a_{tV}}{(1-\beta)K_V}\right]^{\frac{1}{\sigma-1}} U_t\left(\tilde{\omega}_V\right)$ and simplify to obtain

$$\ln R_{tV} = (k - \sigma + 1)\ln U_t\left(\tilde{\omega}_V\right) - \frac{k\sigma}{\sigma - 1}\ln \tau_{tV} - k \ln d_V + \frac{k}{\sigma - 1}\ln A_t + \ln \zeta_V + \ln \tilde{\alpha}_V \tag{39}$$

[34] An alternative condition is that there was an agreement but it ended in the distant past so that any firms that would have entered with costs above c_m^U would have died.

where $\tilde{\alpha}_V \equiv \alpha_V \left(\frac{1}{(1-\beta)K_{1V}}\right)^{\frac{k-\sigma+1}{\sigma-1}}$. Note that in the absence of policy uncertainty $U_t = 1$ and when no upgrading is possible $\zeta_V = 1$ then we have a standard gravity equation (cf. Chaney, 2008). All else equal, the elasticity of exports with respect to the upgrading technology parameter, $\partial \ln R_{tV}/\partial \ln z_V$, is positive and can vary across industries, as we would expect. However, it is also worth noting that exports are log separable in the upgrading factor, so the elasticity is independent of the state under the Pareto distribution.

We can also employ (39) to derive the partial elasticity of exports with respect to policy uncertainty. When the state is $s = m$ for example we have $\frac{\partial \ln R_{mV}}{\partial \gamma}|_{\gamma=0} = (k - \sigma + 1)\left[\frac{\beta p(\tilde{\omega}_V - 1)}{(\sigma-1)(1-\beta t_{22})}\right]$ where the term in square brackets is $\frac{d \ln U_m(\tilde{\omega}_V)}{d\gamma}|_{\gamma=0}$ from (32). If entry and upgrading has negligible impact on the price index then $\tilde{\omega}_V \longrightarrow \left(\frac{\tau_{2V}}{\tau_{mV}}\right)^{-\sigma} < 1$ so increasing the probability of shock will reduce exports. In the presence of aggregate price effects we have $\tilde{\omega}_V < 1$ whenever (28) holds, as shown in the appendix, that is when the direct effect of lower tariffs in industry V on a firm's profits dominates the aggregate price effect.

3 Evidence

We use the model to ask what impact does joining the WTO have on exports, via reductions in policy uncertainty. In particular we analyze how much Chinese export growth to the U.S. following WTO accession can be explained by eliminating the annual and contentious debate over renewal of China's MFN status. Had the U.S. Congress succeeded in revoking MFN treatment of Chinese imports, tariffs would have increased to levels not seen since the Depression era Smoot-Hawley Tariff Act. In this section, we describe how we measure policy uncertainty in this context and test our model. We focus on the predictions for export values, which will reflect both entry and upgrading effects. In section 3.6 we also test the firm entry predictions of the model.

3.1 Empirical Approach

In order to identify the impact of uncertainty on exports via the augmented gravity equation in (39) we must measure the uncertainty term, $U_t(\tilde{\omega}_V)$. If before the agreement, at $s = m$, there was no policy uncertainty ($\gamma = 0$) and thus no probability of the worst case scenario ($t_{m2} = p\gamma = 0$) then the model generates a standard gravity equation with an extra upgrading term. Using this insight as our null hypothesis, we use $\frac{d \ln U_m(\tilde{\omega}_V)}{d\gamma}|_{\gamma=0}$ from (32) to approximate $U_m(\tilde{\omega}_V) = \frac{\beta p(1-\tilde{\omega}_V)}{(\sigma-1)(1-\beta t_{22})}\gamma + u_{mV}$ where u_V is an approximation

error term. We can then rewrite (39) as

$$\ln R_{mV} = -\frac{k-\sigma+1}{\sigma-1}\frac{\beta t_{m2}}{1-\beta t_{22}} g\left(g^{-1} - \left(\frac{\tau_{2V}}{\tau_{mV}}\right)^{-\sigma}\right) - \frac{k\sigma}{\sigma-1}\ln\tau_{mV} - k\ln d_V + \frac{k}{\sigma-1}\ln A_m + \ln\zeta_V + \ln\tilde{\alpha}_V + u_{mV} \tag{40}$$

where we recall that $g = \frac{(1-\beta t_{22})\Sigma_{t=0}^{\infty}(\beta t_{22})^t A_{2t}}{A_m}|_{\gamma=0}$ is common across industries so it can be estimated as part of the coefficient on $\left(\frac{\tau_{2V}}{\tau_{mV}}\right)^{-\sigma}$. Rewriting in terms of estimable parameters we obtain

$$\ln R_{mV} = -b_\gamma\left(1 - \left(\frac{\tau_{2V}}{\tau_{mV}}\right)^{-\sigma}\right) + b_\tau \ln\tau_{mV} + b_d \ln D_{mV} + b_m + b_V + u_{mV} \tag{41}$$

We estimate each of the b_i parameters, which are related to the structural parameters as follows. The first coefficient is $b_\gamma = \frac{k-\sigma+1}{\sigma-1}\frac{\beta t_{m2}}{1-\beta t_{22}} g \geq 0$, so it is predicted to be zero if and only if $t_{m2} = 0$. If there were negligible price effects of switching states s.t. $g = 1$ our estimate of b_γ could be used to calculate the full impact of removing policy uncertainty but otherwise we also have to take into account the term $b_\gamma\left(1 - g^{-1}\right)$, which is captured as part of the time effect $b_m \equiv b_\gamma\left(1 - g^{-1}\right) + \frac{k}{\sigma-1}\ln A_m$. Our approach is to estimate b_γ, which will provide an upper bound on the total effect of uncertainty reduction and then in the quantification section provide an estimate of g that allows to adjust the estimate to reflect the general equilibrium effects.

The applied tariff coefficient is $b_\tau = -\frac{k\sigma}{\sigma-1} < 0$, which is the same deterministic elasticity as a static gravity model. The model assumes the advalorem export cost, d_V, is not state dependent and could thus be absorbed as part of the industry dummy, b_V. In the estimation however, we allow for a more general export cost, which includes an industry specific component and the observable cost of insurance and freight, D_{Vm}, which can vary by industry and over time. More specifically, we assume $\ln d_{Vm} = \ln\tilde{d}_V + \ln D_{mV}$ and in this case we have $b_d = -k < 0$, which is common in heterogeneous firm trade gravity models.[35] The industry effect is then, $b_V = b_d \ln\tilde{d}_V + \ln\zeta_V + \ln\tilde{\alpha}_V$, which *also* includes ζ_V —reflecting technology upgrading and its sunk costs and $\tilde{\alpha}_V$ —reflecting a combination of entry sunk costs, productivity distribution parameter, c_V, and the mass of all Chinese producers in industry V.

The equation above embodies some identifying assumptions, which allow us to clearly link our baseline estimates to the theory. (1) t_{m2} is common across industries because we are interested in the probability of switching policy states or regimes and that is the most relevant case in the empirical application. (2) the Pareto shape parameter k is constant over time and industries, but the upper bound c_V can vary over V. (3) the elasticity of substitution is constant across industries and time. (4) the upgrade technology, sunk

[35] Because tariffs are paid by the importer in the model rather than modeled as transport costs, our tariff elasticity does not reduce to the shape parameter k as in Chaney (2008).

costs, and mass of producers can vary over industries but not over the short time period we consider.

We will relax some of these in the empirical analysis and examine how sensitive the results are to them. It should be clear from this equation that we can relax assumption 4 for example. While the model assumes that the variables in b_V are time invariant, if the mass of Chinese producers (or sunk costs) did change over time, at a similar rate in all industries then this would be controlled for by the time effect. In the robustness section we will also address the possibility of industry-specific growth trends and other potential threats to identification.

Since we cannot observe all the industry characteristics in b_V we require variation over time to identify the impact of uncertainty. Moreover, we are interested in the impact of the *reduction* in uncertainty after the U.S. removed the threat of column 2 tariffs due to China's WTO entry. So our baseline estimates focus on a simple difference, where below $\Delta \ln x_V = \ln x_{0V} - \ln x_{mV}$.

$$\Delta \ln R_V = b_\gamma \left(1 - \left(\frac{\tau_{2V}}{\tau_{mV}}\right)^{-\sigma}\right) + b_\tau \Delta \ln \tau_V + b_d \Delta \ln D_V + b + u_V \tag{42}$$

Note that the impact of uncertainty on the growth of exports reflects only the pre-agreement negative impact. This reflects our assumption that exporters do not anticipate an exit from the agreement, i.e. $t_{00} = 1$. This implies not only $\ln U_0 = 0$ but also that the constant is $b = -\, b_\gamma \left(1 - g^{-1}\right) + \frac{k}{\sigma - 1} \Delta \ln A$ and $u_V = -u_{mV}$.

3.2 Data

We combine trade and policy data from several sources. Trade flow data at the 6 digit level of the Harmonized System (HS6) are obtained from 1996-2005 from the World Bank's World Integrated Trade Solution (WITS). These data are concorded over time to the 1996 version for the HS. We then combine it with policy data on the U.S. statutory MFN and Column 2 tariffs that are also obtained annually from schedules available in WITS at the 8-digit, tariff line level. Most U.S. tariffs, 94% at the 6-digit level in 2005, are levied on a ad valorem basis, but some are specific tariffs levied on a per unit basis or other complex rules. We convert specific tariffs to their ad valorem equivalent (AVE) using unit values from 1996 as a base year. Our base year comparison avoids creating spurious variation in AVE tariffs due to volatility in prices from demand, cost or exchange rate conditions. Our results are robust to the inclusion or exclusion of these AVE measures. We then obtain an ad valorem measure of transport costs using detailed import data from NBER that includes both the customs value of import and the costs of insurance and freight required to ship goods to the U.S. Consistent with our model all ad valorem tariffs and transport costs rates are converted to their iceberg form

and logged. For example, a tariff of 20% takes the value $\tau = 1.2$ in our data.

There are 5,113 HS-6 codes in the 1996 classification and China exported in 3,617 of these in both 2000 and 2005. The baseline analysis focuses on those codes traded in both years so that a log growth rate exists. This selection that at least one firm exports in an HS-6 in each period is not problematic in this setting for two reasons. First, the model predicts that if there is ever a positive mass of Chinese firms in an industry then at least some will be productive enough to export. Second, these continuing HS6 codes account for 99.8% of all import growth from China in this period. Moreover, we will also address the selection issue directly by showing that the results are robust to using midpoint growth rates that allow us to incorporate HS-6 codes that had zero values in either year.

Revisions to the HS in 2002 require that we employ a concordance to make comparisons across time. We use the concordances provided by WITS at the HS-6 level and combine them with 8-digit data on tariff schedules. In order to avoid spurious variation in import growth or trade barriers due only to changes in product classification, we track whether there are changes in the number of 8 digit tariff line headings within concorded HS-6 subheadings and whether the concorded line maps to itself following the revision. This is potentially important to avoid spurious changes in applied tariffs and our uncertainty measure due only to changes in product classification.[36] We thus restrict the baseline sample to stable HS-6 codes that have the same set of 8 digit tariff present from 1996-2005, leaving 3,145 codes. Finally, our baseline regression includes only tariffs levied on an advalorem basis under MFN and Column 2 so our final sample of 2,829 observations. This baseline subsample accounts for 68% of total import growth from China from 2000 to 2005. We provide further information on concordances in the data appendix. As we show in the robustness checks and appendix, broadening the sample by including AVE tariffs, incorporating entry and exit of products or using a more liberal concordance scheme does not change our main results or the summary statistics across samples (table A1).

3.3 Preliminary Evidence

As we note in the introduction, China's WTO accession in December 2001 changed few observable U.S. trade policy barriers relative to other exporters.[37] The ensuing export boom is thus difficult to explain with standard trade models. Our model suggests another source of growth, the accession secured China's pre-existing MFN status permanently and reduced TPU. While China was first granted MFN status by the

[36] For example, suppose an HS-6 code has two tariff lines of 1.06, and 1, for an average tariff of 1.03. If the new revision drops or reassigns the free trade code then the average tariff will increase to 1.06 despite no real change in applied tariffs.

[37] The exception is textiles quotas but these were only lifted in 2005 and can be controlled for empirically.

U.S. in 1980s, it was subject to annual renewal with severe consequences of revocation. China would have faced Smoot-Hawley tariff levels (so called column 2 tariffs) and a trade war would likely ensue. Using our tariff data for the year 2000, we find that for all tariff lines combined, about one-fifth of roughly 5000 tariff lines would go up to at least 50%. For our baseline sample summarized in Table 1, we calculate that the (simple) average tariff China would face in the U.S. would rise from 4% (MFN) to 31% (column 2). Although China never lost MFN status, it came quite close: in the 1990s Congress voted every year on whether to revoke MFN and the House passed such a bill three times.

China's accession to the WTO and the establishing of permanent normal trade relations with the U.S. were far from a foregone conclusion. Foreign and economic relations remained tense well into the late 1990s. In May of 1999, the Chinese embassy in Belgrade was accidently bombed by NATO forces in Serbia. Against this backdrop an agreement with China was signed by then U.S. President Clinton in November of 1999. Nevertheless, votes to revoke MFN recurred in the summer of 2000 and it took until October 10, 2000 for the U.S. Congress to pass the U.S.-China Relations Act granting permanent normal trade relations (PNTR) *contingent* on China's accession to the WTO. In the meantime, a U.S. spy plane collided with the Chinese fighter jet over the South China Sea in April 2001. Protracted negotiations over China's WTO accession meant votes were held again over whether to revoke MFN in the summer of 2001. The president was required to determine whether the terms of China's WTO accession satisfied its obligations under the Act. Otherwise the U.S. could opt-out under Article XIII of the WTO, a right it had exercised with respect to other members of the WTO. China joined the WTO on December 21, 2001 and the U.S. officially granted PNTR on January 1, 2002.[38]

We will estimate the impact of the threat of column 2 tariffs on U.S. imports from China and how much its removal can account for in the recent boom. In our theoretical framework the central variable to identify the effect of TPU is the proportion of profits lost conditional on a bad shock, $1-(\tau_{tV}/\tau_{hV})^{\sigma}$. We use the U.S. MFN tariff in product V for τ_{tV} and the respective column 2 tariff for the worst case scenario, τ_{hV}.[39] In the baseline sample we find that on average the potential profit loss measured this way was 52% (last column of Table 1). The standard deviation is 20% so there is a reasonable amount of variation across industries. Importantly there is also substantial variation in import growth, which suggests that the boom can't be explained by aggregate shocks. Average growth in the baseline sample between 2000, the year before

[38] A detailed history of U.S. permanent normal trade relations policy with respect to China and other countries can be found in Pregelj (2001).

[39] We do not use the U.S. bound tariff commitments to compute the uncertainty measure for two reasons. First, bound tariff commitments only apply to WTO members so if China's MFN status was revoked prior to WTO accession the U.S. would revert to column 2 tariffs. Second, after accession Chinese exporters could consider the uncertainty induced by the possibility of moving from MFN to the bound tariffs but those two are identical for the modal tariff line.

China's WTO accession, and 2005 is 127 log points with a standard deviation of 162.[40]

We then divide the sample into terciles according to the uncertainty measure and recompute the statistics for the low and high terciles. As we see in Table 1, the import growth was 115 log points for low uncertainty whereas it was higher, 133, for high uncertainty industries, a mean difference that is statistically different. Changes in tariffs and transport costs over the same period were miniscule by comparison, averaging one half percent or less. But underscoring the risk to prospective entrants into the U.S. market, the average column 2 tariff was nearly 40% in high uncertainty goods, which translates into a potential profit loss of 64% in the typical industry if MFN status had been revoked.

The model also has predictions for variety entry, i.e. entry of firm-product pairs. Given our data we can only examine these indirectly by considering product entry. In our model, a variety is a firm-sub product pair within an HS6 code so we calculate the growth in the number of HS-10 traded products. In 79% of high uncertainty HS-6 codes there was a growth in underlying varieties whereas that occurred for only 67% of HS-6 codes with low uncertainty, a difference that is statistically significant.

We focus on estimating the model for Chinese export growth, but also test the predictions for entry in section 3.6.

3.4 Estimates: policy uncertainty and exports

We begin by estimating the baseline model and testing its predictions. We then show these results are robust to weaker identifying assumptions and a set of alternative measures of protection.[41]

Baseline

We estimate the model on the baseline sample described above using equation (42) and $\sigma = 3$. The results in Table 2 are consistent with the structural interpretation of the parameters. In column 1 we see that the coefficient on pre-WTO accession uncertainty, b_γ, is positive and significant. The coefficients on tariffs and transport costs are negative and significant, as predicted. The estimation equation contains an over identifying restriction $b_\tau = \frac{\sigma}{\sigma-1} b_d$, which we are unable to reject. We therefore re-estimate the model in column 2 with the restriction imposed. This increases the precision of the model across all coefficients. In the robustness checks that follow, we report both unconstrained and constrained regression whenever possible. In Table A3 we construct the uncertainty variable using alternative $\sigma = 2, 3, 4$ and find very similar results.

[40] Much of the growth in the overall sample was concentrated in machinery, textiles, furniture, and metals sectors as noted by Berger and Martin, 2013.

[41] Summary statistics for the extended estimation samples can be found in the data appendix.

Sector level growth trends

In (42) we assumed that the industry effect b_V captured variables such as sunk costs and the mass of foreign producers in an industry. The model assumes these parameters are time invariant, but we now address the possibility that they vary over time in the data. If there was unexpected growth in any industry variable that was common to all industries then the baseline estimate controls for it through the constant term, b. We can also allow that *growth* to be common to sectors (groups of industries) by including a full set of 21 sector dummies in the *difference* equation (42). Obviously, either scenario admits an IID industry specific term, which is included in the error u_V.

We report the results that control for sector specific growth *trends* in columns 3 and 4 of Table 2. The pattern of coefficients is similar to the baseline. Quantitatively, the coefficient on uncertainty falls slightly but remains positive and significant. The coefficients on tariffs and transport costs are stable, but tariffs are no longer significant in the unconstrained regressions. We note that the restriction on the tariff and transport cost coefficients cannot be rejected and imposing the constraint increases the precision of all estimated coefficients.[42] In Table A3 we construct the uncertainty variable using alternative $\sigma = 2, 3, 4$ and find very similar results.

As we show in the data appendix, we can further relax the identifying assumption of a fixed industry effect in levels to accommodate growth trends at the industry level that are persistent. If an industry variable is growing at the same rate in the pre and post WTO period then we can remove it by taking the double long difference of the post-WTO growth (2005-2000) and a pre-WTO period (1999-1996). Our results are robust to this additional difference-of-differences specification (see appendix Table A6). Moreover, we find no effect of uncertainty in a single difference regression during the pre-WTO period, which serves as a falsification test of the model (since there is no obvious reason why this source of policy uncertainty changed over that period).

Additional measures of protection

The regressions in columns 3 and 4 of Table 2 already control for unobserved, sector level trade barriers that might impact the growth of exports from China. Nevertheless, there are barriers to trade beyond tariffs that vary at the industry (HS6) level as well. These include temporary trade barriers (TTBs) such as anti-dumpting duties, countervailing duties, special safeguard measures and China-specific special safeguards. We create binary indicators for TTBs from the World Bank's TTB database (Bown, 2012) and match then

[42] One reason for this increase in precision is that applied tariff changes are very small during our sample period, see table 1, so there may be a few influential observations. In table A4 we address this possibility using a robust regression method and find results that are qualitatively similar to the baseline but where the tariff change is always significant in the restricted and unrestricted versions.

to their corresponding 1996 HS6 industry. Following China's accession to the WTO it also became eligible to benefit from the gradual phase-out of quotas in textile products that was agreed under the Multi-Fiber Agreement (MFA) and was implemented by 2005. Additional details on the TTB and MFA indicators appear in the data appendix.

In Panel A of Table 3, we examine whether controlling for changes in TTBs or MFA quotas affect our results. For comparison, we reproduce the baseline results in column 1. In columns 2 and 3 we include a regressor for the change in the binary indicator for both MFA quotas or TTBs. When section fixed effects are included (column 3), both the MFA and TTBs regressors are negative and significant, as we would expect, but they do not change the coefficient on the uncertainty variable. The MFA dates back to the 1980s and its phaseout was implemented with the Uruguay Round in 1996 before China was a member of the GATT/WTO. As such, it is plausibly exogenous as a barrier to China's imports. TTBs such as anti-dumping and safeguards however, may be endogenous because their application can respond to import surges from China. To the extent that these surges are more likely in some sectors, our sector effects in column 3 already control for this issue. To address the possibility that this reverse causality could also occur within sectors, we instrument the change in TTB status with its level binary indicators in 1997 and 1998. When we do so in column 4 we find that the coefficient for uncertainty remains virtually unchanged relative to the OLS version in column 3 of that table or without the TTB variable (column 3 Table 2).[43] We also find that the constrained version, $b_\tau = \frac{\sigma}{\sigma-1} b_d$, yields very similar coefficients for the uncertainty, tariff and transport cost variables if we include the TTB and MFA (column 5 Table 3) or not (column 4 Table 2).

Finally, in Panel B of Table 3 we examine whether our results are robust to the inclusion of the ad-valorem equivalent (AVE) of specific tariffs. Including the AVE tariffs increases our sample size to 3,145 so it also allow us to address if there is any potential sample selection issue in the baseline sample that excluded HS-6 codes that contained only specific tariffs. We use AVEs to compute both the change in applied tariffs and uncertainty and find that the latter is robustly positive and significant across all specifications. As may be expected, including AVE tariffs introduces noise and measurement error into the computation of tariff changes. This error biases the coefficient on tariffs toward zero and so in the subsequent robustness and quantification we focus on results for industries in our baseline sample with statutory ad-valorem tariffs.

Concordance and sample selection

The baseline sample focuses on HS6 codes that are stable over the sample period. The goal was to

[43] The two instruments pass a Sargan over-identifying restriction test and we also fail to reject the exogeneity of the TTB variable using a Durbin-Wu-Hausman test. The instruments have significant explanatory power in the first stage. The first stage F-statistic for the baseline sample is below the usual rule to avoid weak instruments of 10 but the one for the full sample, in Table A5 is over 10.

avoid potential issues that arise from matching HS-6 codes over time. For example, if several HS-2002 codes are combined to match a single 1996 code then there may be higher than expected growth in that code simply because of aggregation. The baseline sample accounts for about 87% of the codes where there was trade in both these periods and captures about 67% of the growth in exports. Thus we test the robustness of the results to this sample selection. The estimates for the full sample in Table A5 are quite similar to the analogous ones in Table 3. The point estimates tend to be slightly lower for the tariff and transport cost, which may indicate there is some attenuation bias that arises from the HS-6 codes that are concorded. Concordance may raise other issues when examining product entry, as we describe below, and therefore we will focus on the baseline sample for the quantification. But there would not be a large difference if we used the full sample for the quantification.

We can also expand our sample to include HS-6 codes that transition from traded to non-traded status between 2000 and 2005.[44] Because we cannot compute log changes of these transitions, we accommodate them using a mid-point growth rate as our dependent variable in estimation equation (42) given by $\Delta \ln R_V \approx \frac{R_{tV}-R_{t-1,V}}{(R_{tV}+R_{t-1,V})/2}$.[45] The mid-point growth rate is symmetric and bounded on $[-2, 2]$, which rescales coefficients but not their relative magnitudes. When we re-run the specifications in Table 3 using this alternative dependent variable (and the resulting expanded sample) we continue to find a positive and significant coefficient for the uncertainty measure.[46]

3.5 Counterfactuals and quantification

We now use the estimates and model structure to quantify the effect of the policy uncertainty reduction on trade, prices and consumer welfare.

Using the parameter definitions in (41) derived from (40) we can provide an expression for the average "partial effect" of eliminating uncertainty that holds general equilibrium price effects fixed as follows

$$E_V \left(\ln R_{0V} - \ln R_{mV} \right) |_{\tau,D,P} = b_\gamma E_V \left(g^{-1} - \left(\frac{\tau_{2V}}{\tau_{mV}} \right)^{-\sigma} \right) \leq b_\gamma E_V \left(1 - \left(\frac{\tau_{2V}}{\tau_{mV}} \right)^{-\sigma} \right) \tag{43}$$

This reflects a general equilibrium effect, $g \geq 1$, due to the possibility of a worst case scenario present before the agreement. Therefore the expression on the RHS of the inequality is an upper bound for this partial effect. To obtain this upper bound we simply take the product of the estimated coefficient and the sample

[44] Strictly speaking, in order for our model to predict for zeroes we would require a Pareto productivity distribution that is truncated above.

[45] The measure is equivalent to log changes up to a second order approximation around the mean of $(R_{tV} - R_{t-1,V})/2$.

[46] The results are available on request. The magnitude of the coefficients is not directly comparable with the baseline results because of the rescaling of the dependent variable.

mean of the uncertainty variable. We employ the estimate in column 4 of Table 2, $\hat{b}_\gamma = 0.614$, and find that over the 5 year period, the uncertainty removal lead to export growth of up to 32 log points, as shown in the top row of Table 4.

To determine how close the upper bound is to the real effect recall that $g \in [1, \left(P_2^D/P_m^D\right)^{\sigma-1}]$. From (43) we can see that even if $b_\gamma \neq 0$, as estimated, the average effect could still be zero if $g^{-1} = E\left(\frac{\tau_{2V}}{\tau_{mV}}\right)^{-\sigma}$. But this would require the price index in the worst case scenario to be 1.45 times higher than under MFN ($\sigma = 3$). This is an implausibly large impact of column 2 tariffs even if fully and irreversibly implemented given the import penetration of China, which was about 0.02 in 2000 and 0.04 in 2005. Therefore any reasonable estimates of g will not overturn the sign of the estimated uncertainty effect, the question is whether the magnitude is very different from the upper bound of 32 log points.[47]

In the appendix section A.5.1 we show how to use the model to approximate P_2^D/P_m^D, in a way that can be combined with data and our estimates to derive an upper bound for g. The approximation of the ratio of price indices is a weighted average of tariff changes multiplied by an aggregate coefficient that depends on parameters k and σ and the aggregate import penetration of China.[48] Doing so yields a price index increase of about 2.1 log points and thus an upper bound for $g = 1.043$. Therefore, the estimate of the average direct effect that takes this into account is $b_\gamma \mathbb{E}\left(g^{-1} - \left(\frac{\tau_{2V}}{\tau_{mV}}\right)^{-\sigma}\right) = 0.614 \times (1/1.043 - 0.47) = 0.30$. Thus our initial upper bound overestimates the partial effect by about two log points.

Next we calculate the average total effect, which also includes the price impact generated by changing uncertainty alone. Adding the price effect subsumed in the A term in (40) to the partial effect we obtain the total effect expression

$$E_V\left(\ln R_{0V} - \ln R_{mV}\right)|_{\tau,D} = b_\gamma E_V\left(g^{-1} - \left(\frac{\tau_{2V}}{\tau_{mV}}\right)^{-\sigma}\right) + k\left(\ln P_0/P_m\right)|_{\tau,D}$$

To calculate the price effect we employ the model structure and expression in (35), which we relate to the data and model parameters in Appendix section A.5.1. We obtain a proportional change in the price index due to uncertainty, $\ln P_0/P_m \approx -\gamma \frac{d \ln P_m}{d\gamma}|_{\gamma=0}$, of about -0.65 percent so $k\left(\ln P_0/P_m\right)|_{\tau,D} = -.019$. Therefore the total impact of uncertainty on average import growth is $0.30 - 0.019$, i.e. about 28 log points.

[47] To see this note that in our baseline we would require $g^{-1} = E\left(\frac{\tau_{2V}}{\tau_{mV}}\right)^{-3} = 0.47$ and therefore $\left(\frac{P_2^D}{P_m^D}\right)^{\sigma-1}$ to be at least 2.09. The import penetration figures are from Autor et al (Forthcoming). Auer and Fischer (2010) estimate that a 1 percentage point increase in import penetration would lower the US PPI by 2.35% so even if China went from the post agreement penetration to no trade with the US the impact on the PPI would be at most 4×2.35%.

[48] We use $\sigma = 3$ and $k = 2.95$ (the value implied by the transport cost coefficient in column 4 of Table 2). Since the approximation is around the deterministic policy scenario we employ the post-agreement import levels to weight up the tariff changes from post agreement to the column 2 levels (but obtain similar results if we used the pre agreement weights) and use the import penetration level in 2005 (which is twice as high as before).

One way to quantify the importance of this policy uncertainty removal for trade is to translate it into an applied tariff equivalent. For the partial effect this requires us to simply divide the impact of uncertainty by the tariff elasticity in the baseline estimate, 0.30/4.42. Thus the average partial impact of uncertainty before the agreement was equivalent to having a 6.7 percentage point tariff on all goods. The equivalent advalorem transport cost factor reduction of uncertainty is 10 percentage points, which is larger than the average transport cost factor in 2000. The advalorem equivalents are similar for the average total effect since tariffs and transport costs also have price index effects, which we take into account in calculating the advalorem equivalent.

We also quantify how much of the observed import growth can be accounted for by the uncertainty removal. More specifically, denoting aggregate imports by R, and the level predicted by removing uncertainty alone by $\hat{R}$ we calculate the ratio of the arithmetic growth rates, which simplifies to $(\hat{R}-R_{00})/(R_{05}-R_{00})$. In column 2 of table 4 we use $\hat{R}=\Sigma_V R_{00V}\exp\left(\hat{b}_\gamma\left(g^{-1}-\left(\frac{\tau_{2V}}{\tau_{mV}}\right)^{-\sigma}\right)\right)$ and find that uncertainty accounted for 30% of the observed import growth. In the third column we find that including the price effect reduces the share to 28%.[49] Recall that the baseline sample accounts for 68% of total import growth because it excludes certain industries to avoid potential concordance issues. However, the parameter estimates for the full sample (which accounts for 99.8% of the growth) are very similar as we show in Tables A2 and A5. When we re-calculate the growth share accounted for by uncertainty in the full sample we find that it is nearly the same as with the baseline sample, about 1 percentage point higher than each of the scenarios in Table 4.

As we can see in Table 4, the share of import growth when we take all general equilibrium price effects into account is larger than when we ignore them. This suggests there is a potentially important welfare impact, which we now quantify. The expected welfare cost to workers of increasing uncertainty relative to the deterministic case around the MFN tariffs is $\ln(W_m(\gamma)/W_m^D)\approx\gamma\frac{d\ln W_m(\gamma)}{d\gamma}|_{\gamma=0}$. Recall that the impact of γ is derived in 36 and includes a "*within state welfare effect*", which when multiplied by γ yields $-\mu\gamma\frac{d\ln P_m}{d\gamma}|_{\gamma=0}$ and is equal to an expected welfare change of -0.65μ percent for the baseline sample and -0.72μ for the full sample. The increase in uncertainty also induces a "*mean state switching welfare effect*" due to the fact that it becomes more likely that tariffs will transition to a new state. Calculating this requires information regarding other transition probabilities (t_{22} and p and the consumer discount factor, $\tilde{\beta}$) that we do not have. However, given that the applied tariffs under the MFN and post agreement state were very similar, we can safely say that the mean state switching effect would further decrease welfare.

To place the welfare effect in context, consider a consumer that spends all the income on differentiated

[49] For the third column we use $\hat{R}=\Sigma_V R_{00V}\exp\left(\hat{b}_\gamma\left(g^{-1}-\left(\frac{\tau_{2V}}{\tau_{mV}}\right)^{-\sigma}\right)+k\left(\ln P_0/P_m\right)|_{\tau,D}\right)$.

products ($\mu = 1$). In this case increasing uncertainty back to the pre agreement level would reduce expected welfare by at least about 0.7 percent in the context of this model (the within state effect) and at most by about 2 percent—the full change in the price index in the deterministic vs. column 2 state. By comparison, Broda and Weinstein (2006) estimate that the gains from new imported varieties in the U.S. between 1990-2001 was 0.8 percent.[50]

3.6 Additional results: policy uncertainty and entry

We now examine the effect of policy uncertainty on firm entry. Since we do not have access to firm level data at this point we explore the product data at a more disaggregated level than the HS-6. More specifically, we examine the change in the number of traded products within each industry as a proxy for firm entry. We show that if the mapping from products to number of firms is similar across industries then we can provide a quantification of the effect of uncertainty on firm entry. Given the data limitations, our goals are simply to examine whether there is corroborating evidence for the entry uncertainty channel identified in our trade flow regressions and provide some quantification of its importance.

The model predicts that the number of Chinese exporting firms to the U.S. in an industry V at time t, denoted by n_{tV}, is at least $G(c_{tV}^U)N_V$ —the fraction $G(\cdot)$ of all available Chinese varieties N_V that have costs below the entry threshold. Moreover, as we noted in deriving the export equation, when the current policy conditions are no worse than in the past, e.g. when $s = 0$ or m at time t, then $n_{tV} = G(c_{tV}^U)N_V$. We can then use the Pareto assumption and the derived cutoff, c_{tV}^U, to provide a general expression for the number of firms before or after the agreement

$$\ln n_{tV} = k \ln U_{tV} - \frac{k\sigma}{\sigma - 1} \ln \tau_{tV} - k \ln d_V + \frac{k}{\sigma - 1} \ln A_t + \ln \frac{N_V}{c_V^k} \left(\frac{1}{(1-\beta) K_V} \right)^{\frac{k}{\sigma - 1}}$$

Differencing this equation between one period before and after WTO accession, as done for the export equation, using the approximation for U_{tV} and allowing transport costs to vary over time we obtain

$$\Delta \ln n_{tV} = \frac{k}{\sigma - 1} \frac{\beta t_{m2}}{1 - \beta t_{22}} g \left(g^{-1} - \left(\frac{\tau_{2V}}{\tau_{mV}} \right)^{-\sigma} \right) - \frac{k\sigma}{\sigma - 1} \Delta \ln \tau_V - k \Delta \ln d_V + \frac{k}{\sigma - 1} \Delta \ln A + u_V \ . \quad (44)$$

We note three points that are relevant for the subsequent analysis. First, the elasticity of entry with respect to tariffs and transport costs are the same as the respective elasticities in the export equation.

[50] As is standard in most trade models neither of these quantificaitons takes into account services. However, the model and calculations do take into account the large fraction of non-traded goods since many of the differentiated goods are produced by firms that are not productive enough to export. This is reflected in the low values of import penteration from China, which captures imports/US consumption.

Second, the semi-elasticity of entry with respect to uncertainty is higher by a factor $k/(k-\sigma+1)$ since it does not affect the intensive margin directly unless firms upgrade. Third, the model predicts that the growth in the number of upgrading firms will be exactly the same as the one for entry since the cutoff for upgrading is proportional to the entry upgrade by a constant factor.

Since the true change in firm entry is unobserved (to us) we will treat it as a latent variable and model how it maps to observable changes in exported products. We assume the log of the number of firms, n_{tV}, can be mapped to the number of products, $pcount_{tV}$, with positive exports via a continuous, increasing, differentiable function $F(\cdot)$ such that $\ln(pcount_{tV}) = F(\ln n_{tV})$. If there was only one firm in an HS-6 industry and it produces a single variety then we would observe one traded product (an HS-10 category) in an industry. We cannot observe more traded products than the maximum number tracked by customs in each industry, i.e. the total number of HS-10 categories in an HS-6. So clearly we have a lower bound $F(\ln n_{tV} = 0) = 0$ and an upper bound $\ln(pcount_{tV}^{\max}) = F(\ln n_{tV} > \ln n_{hV})$ where n_{hV} is the (unobserved) threshold where all HS-10 product categories in an HS-6 industry have positive values. If we assume product counts and firm-product varieties are continuous, then $F' \geq 0$ for $n_V \in (0, n_{hV})$ and zero otherwise. We log linearize the equation of product counts around $\ln n_{t-1V}$. Then the change in products between t and and $t-1$ is $\Delta \ln(pcount_{tV}) \approx F'(\ln n_{t-1V}) \Delta \ln n_{tV}$. Therefore, if we use the growth in the product count as a proxy for entry and want to identify the coefficients in (44) up to a constant, F' , we must impose the identifying assumption that F' is similar across industries. We can then obtain the following product level regression

$$\Delta \ln(pcount_V) = \tilde{b}_\gamma \left(1 - \left(\frac{\tau_{2V}}{\tau_{mV}}\right)^{-\sigma}\right) + \tilde{b}_\tau \Delta \ln \tau_V + \tilde{b}_d \Delta \ln d_V + \tilde{b} + e_V \tag{45}$$

The coefficients obtained from a linear regression rescale the parameters in (44) by F'. Therefore the predictions are that $\tilde{b}_\gamma = \frac{k}{\sigma-1}\frac{\beta t_{m2}}{1-\beta t_{22}} g F' > 0$, $\tilde{b}_\tau = \frac{-\sigma k}{\sigma-1} F' < 0$ and $\tilde{b}_d = -kF' < 0$ and the constant $\tilde{b} = -\tilde{b}_\gamma\left(1 - g^{-1}\right) + F'\frac{k}{\sigma-1}\Delta \ln A$. Note that $F' \in [0,1]$ as a new variety fills at most one new product category so we would expect the estimates to understate the structural parameters of (44).[51]

In going from these specifications to the data, we carefully account for the maximum number of tradable products within each HS6. We use this information to impose sample restrictions on the regression consistent with our specification of the $F()$ function. We drop observations if an industry already trades the maximum number of products available at the beginning and end of the sample – a "max-to-max" transition where $F' = 0$– as well as industries that are non-traded throughout the sample – "zero-to-zero" transitions. This means we have a symmetric sample restriction at the upper and lower bounds suggested by our mapping F.

[51] The error term $e_V = F' u_V$ plus the approximation error of using the growth in product count instead of the number of firms.

In estimating the log changes specification we must focus only on the industries with some traded product in both periods, which is what we also did in the baseline trade flow regression. We will also present an ordered probit to analyze if the results are substantially different when we allow transitions from zero to positive number of products in an industry and vice versa.

In Table 5, we report the results of the specifications where we use $\sigma = 3$. The first column shows the baseline specification and we find that all three variables have the predicted sign and are statistically significant. In column 2 we control for section effects and find similar results. The estimates are noisier than those in the export equation, as may be expected given that must now use less than half of the observations. We test and fail to reject that $\tilde{b}_\tau/\tilde{b}_d = \sigma/(\sigma-1)$ and therefore column 3 imposes this constraint on the specification with sector effects. Below we use the latter specification for quantification, which is analogous to the one we focused on for the export growth. We can see that the tariff and transport cost elasticity are lower than their respective values in the export equation (Table 2 column 4), which is consistent with the fact that the parameters here are scaled by $F' \in [0,1]$.

In order to quantify the impact of uncertainty on entry we can perform similar exercises to the ones using the import estimates. Therefore, Table 6 is the analogous of Table 4 for entry. First, recall that the tariff advalorem equivalent of removing uncertainty can be obtained as the average change in tariffs, $E_V(\Delta \ln \tau_V)$, that would deliver the same expected increase in entry as the uncertainty removal, i.e. $E_V(\Delta \ln \tau_V)\frac{\partial \ln n_V}{\partial \ln \tau_V} = E_V(\Delta \ln n_V)|_{\tau,d,P}$. Using (44) we obtain $E_V(\Delta \ln \tau_V) = E_V\left(g^{-1} - \left(\frac{\tau_{2V}}{\tau_{mV}}\right)^{-\sigma}\right)\frac{k}{\sigma-1}\frac{\beta t_{m2}}{1-\beta t_{22}} g\left(\frac{-\sigma k}{\sigma-1}\right)^{-1} = E_V\left(g^{-1} - \left(\frac{\tau_{2V}}{\tau_{mV}}\right)^{-\sigma}\right)\tilde{b}_\gamma/\tilde{b}_\tau = 0.11$. As the model predicts, the impact of uncertainty relative to tariffs is higher for entry (0.11) than for trade flows (0.067). Similarly we can calculate the transport cost advalorem equivalent, which is 0.164, and verify that it is higher than for trade flows (0.10).

In order to compute the impact of uncertainty on entry including the general equilibrium price effects we require an estimate of F'. We can obtain it by using the cross equation restriction implied by the model $F' = \tilde{b}_d/b_d = 0.524/2.95 = 0.178$. Using this we obtain the general equilibrium impact of uncertainty on entry as $\frac{\tilde{b}_\gamma}{F'}E_V\left(g^{-1} - \left(\frac{\tau_{2V}}{\tau_{mV}}\right)^{-\sigma}\right) + k(\ln P_0/P_m)|_{\tau,D} = 0.46$.[52] While there are wide confidence intervals around this estimate it is broadly consistent with the model in the sense that the predicted impact of uncertainty on entry growth is higher than on exports. The magnitude also seems consistent with the *total* growth in the number of exporting firms in China over this period was 0.83 (Ma et al., 2013). If the *average* growth at the HS-6 level of exporters to the U.S. is not too far from the total growth then our counterfactual would imply that policy uncertainty removal could account for at least half of that increase.[53]

[52] The advalorem equivalent with the general equilibrium price effects are similar to those in the absence of price index effects.
[53] The second row in Table 7 uses the growth in the total number of exporters since we do not know the average growth in

We can also proxy the change in firms by using the discrete change in the number of traded products. Here we use the distribution function of an ordered probit to map unobserved changes in the cutoff to the probability of observing a decrease, no change, or increase in the number of traded products.[54] Column 4 in Table 5 uses the same sample described above and includes sector effects and confirms the sign predicted by the model. However, only the uncertainty variable is statistically significant.[55] In column 5, we relax the assumption that a product must be traded in both periods and find that this does not affect the sign or significance of the uncertainty variable.[56]

4 Conclusion

We assess the impact of U.S. trade policy uncertainty (TPU) toward China in a tractable general equilibrium framework with heterogeneous firms. We show that increased policy uncertainty reduces investment in export entry and technology upgrading, which in turn reduces trade flows and real income for consumers. We apply the model to the period surrounding China's accession to the WTO in late 2001. WTO membership lead the U.S. to grant permanent most-favored-nation (MFN) tariff treatment to China, ending the annual threat to revoke MFN and subject Chinese imports to Smoot-Hawley tariffs. While much work has focused on the costs of Chinese import penetration to employment and wages, we focus on the potential for gains from reducing trade policy uncertainty.

We derive observable, theory-consistent measures of policy uncertainty and estimate its effect on trade flows, prices and welfare. Had MFN status been revoked, Chinese exporters would have faced an average profit loss of over 50%. Our approach nests a role for trade policy uncertainty within a deterministic, standard gravity-style regression. We find evidence that exporters placed positive probability weight on the likelihood of losing MFN status, consistent with concerns of business and policymakers at the time. By moving to permanent MFN status via WTO accession, the reduction in trade policy uncertainty can account for about 30% of the increase in Chinese exports to the U.S. in 2000-2005. The welfare cost of this uncertainty was at least 0.7 percent of consumer real income (if most of their income was spent on differentiated goods). We therefore also identify and quantify a new source of gains from trade agreements, even if applied tariff changes are small.

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the number of firms across HS-6.

[54] In the data, the discrete changes in products ranges from -5 to 20, with sparse support below -3 and above 5. The state space for the estimated model of discrete changes ranges from a lower limit of $\Delta pcount_{tV} \leq -1$ to an upper limit of $\Delta pcount_{tV} \geq 1$ for a total of three states.The estimated cutpoints are statistically different at the 5% level.

[55] One possible reason is that transport cost and tariffs may not vary enough to affect whether or not there is an increase in the number of firms but conditional on a big enough shock leading to entry they affect how many will enter.

[56] This requires that we impute trade costs for industries that switch from non-traded to traded, or vice versa, as described in the data Appendix.

Our findings have implications beyond this particular important event. They suggest that U.S. threats to impose tariffs against "currency manipulators" or not renew unilateral preferences to developing countries are currently reducing imports and consumer welfare. More broadly, our results provide evidence that one of the important channels through which the WTO can increase trade and welfare is by reducing trade policy uncertainty and thereby increasing export entry and technology upgrading.

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A Theory Appendix

A.1 Entry threshold

In this appendix we provide the details for deriving the entry thresholds presented in section 2.2.

Derivation of expected value of exporting (MFN), eq. (9)

$$\Pi_e(a_m,c)\left(1-\beta t_{mm}\right)=\pi(a_m,c)+\beta\left[t_{m0}\Pi_e(a_0,c)+t_{m2}\Pi_e(a_2,c)\right]$$
$$\Pi_e(a_m,c)\left(1-\beta t_{mm}\right)=\pi(a_m,c)+\beta\left[t_{m0}\frac{\pi(a_0,c)+\beta t_{0m}\Pi_e(a_m,c)}{1-\beta t_{00}}+t_{m2}\frac{\pi(a_2,c)+\beta t_{2m}\Pi_e(a_m,c)}{1-\beta t_{22}}\right]$$

$$\Pi_e(a_m,c)\left(1-\beta\left(t_{mm}+\beta\left[t_{m0}\frac{t_{0m}}{1-\beta t_{00}}+t_{m2}\frac{t_{2m}}{1-\beta t_{22}}\right]\right)\right)=\pi(a_m,c)+\beta\left[t_{m0}\frac{\pi(a_0,c)}{1-\beta t_{00}}+t_{m2}\frac{\pi(a_2,c)}{1-\beta t_{22}}\right]$$
$$\Pi_e(a_m,c)=\frac{\pi(a_m,c)}{1-\beta t_m}+\frac{\beta}{1-\beta t_m}\Sigma_{s\neq m}t_{ms}\frac{\pi(a_s,c)}{1-\beta t_{ss}}$$

Derivation of expected value of waiting (MFN), eq. (13)

To obtain (13) we simplify (12) using (10) and (8) evaluated at the threshold for entry at MFN along with (6), i.e. $\Pi_e(a_m,c_m^U)-K=\Pi_w(a_m,c_m^U)$

$$\Pi_w(a_m,c_m^U)=\frac{\beta}{1-\beta t_{mm}}\left[t_{m2}\frac{\beta t_{2m}\left[\Pi_e(a_m,c_m^U)-K\right]}{1-\beta t_{22}}+t_{m0}\left[\frac{\pi(a_0,c_m^U)+\beta t_{0m}\Pi_e(a_m,c_m^U)}{1-\beta t_{00}}-K\right]\right]$$
$$\Pi_w(a_m,c_m^U)=\frac{\beta t_{m0}}{1-\beta\left(t_{mm}+t_{m2}\frac{\beta t_{2m}}{1-\beta t_{22}}\right)}\left[\frac{\pi(a_0,c_m^U)+\beta t_{0m}\Pi_e(a_m,c_m^U)}{1-\beta t_{00}}-K\right]$$

Derivation of cutoff MFN

Using the value of export in (9) and the value of waiting in (13), we can use the indifference condition in (6) to solve for the cutoff c_m^U. Below we simplify notation using

$\tilde{t}-t_{m0}\equiv t_{mm}+t_{m2}\frac{\beta t_{2m}}{1-\beta t_{22}}$

$\Pi\equiv\Pi_e(a_m,c_m^U)$

$$\Pi-K=\frac{\beta t_{m0}}{\left(1-\beta\left(\tilde{t}-t_{m0}\right)\right)}\left[\frac{\pi(a_0,c_m^U)+\beta t_{0m}\Pi}{1-\beta t_{00}}-K\right] \tag{46}$$
$$\left(1-\beta\left(\left(\tilde{t}-t_{m0}\right)+\frac{t_{m0}\beta t_{0m}}{1-\beta t_{00}}\right)\right)\Pi=\frac{\beta t_{m0}\pi(a_0,c_m^U)}{1-\beta t_{00}}+K\left(1-\beta\tilde{t}\right)$$
$$\left(1-\beta t_m\right)\Pi=\frac{\beta t_{m0}\pi(a_0,c_m^U)}{1-\beta t_{00}}+K\left(1-\beta\tilde{t}\right)$$

where $t_m\equiv t_{mm}+\beta\left[t_{m0}\frac{t_{0m}}{1-\beta t_{00}}+t_{m2}\frac{t_{2m}}{1-\beta t_{22}}\right]=\left(\tilde{t}-t_{m0}\right)+\frac{t_{m0}\beta t_{0m}}{1-\beta t_{00}}$

Now we use (9) to replace $\left(1-\beta t_m\right)\Pi_e(a_m,c)$

$$\pi(a_m,c_m^U)+\beta\Sigma_{s\neq m}t_{ms}\frac{\pi(a_s,c_m^U)}{1-\beta t_{ss}}=\frac{\beta t_{m0}\pi(a_0,c_m^U)}{1-\beta t_{00}}+K\left(1-\beta\tilde{t}\right)$$
$$\pi(a_m,c_m^U)+\beta t_{m2}\frac{\pi(a_2,c_m^U)}{1-\beta t_{22}}=K\left(1-\beta\tilde{t}\right)$$

Solving for the cutoff and simplifying

$$\begin{aligned}
\left(c_m^U\right)^{\sigma-1} &= \frac{1}{K\left(1-\beta\tilde{t}\right)}\left[a_m+\beta t_{m2}\frac{a_2}{1-\beta t_{22}}\right] \\
c_m^U &= \left[\frac{a_m}{K\left(1-\beta\tilde{t}\right)}\right]^{\frac{1}{\sigma-1}}\left[1+\frac{\beta}{1-\beta t_{22}}t_{m2}\left(\frac{\tau_2}{\tau_m}\right)^{-\sigma}\right]^{\frac{1}{\sigma-1}} \\
c_m^U &= \left[\frac{a_m}{K\left(1-\beta\right)}\right]^{\frac{1}{\sigma-1}}\left[\frac{1-\beta}{1-\beta\tilde{t}}\left(1+\frac{\beta t_{m2}}{\left(1-\beta t_{22}\right)}\left(\frac{\tau_2}{\tau_m}\right)^{-\sigma}\right)\right]^{\frac{1}{\sigma-1}} \\
c_m^U &= c_m^D\left[\frac{1-\beta}{1-\beta\tilde{t}}\left(1+\frac{\beta t_{m2}}{\left(1-\beta t_{22}\right)}\left(\frac{\tau_2}{\tau_m}\right)^{-\sigma}\right)\right]^{\frac{1}{\sigma-1}} \\
c_m^U &= c_m^D U_m
\end{aligned}$$

Proof for $\frac{d\ln c_m^U}{d\gamma}<0$

$$\begin{aligned}
\frac{d\ln c_m^U}{d\gamma} &= \frac{1}{\sigma-1}\frac{d}{d\gamma}\left[\ln\frac{1-\beta}{1-\beta\tilde{t}}\left(1+\frac{\beta\gamma p}{1-\beta t_{22}}\left(\frac{\tau_2}{\tau_m}\right)^{-\sigma}\right)\right] \\
&= \frac{1}{\sigma-1}\left(-\frac{d\ln\left(1-\beta\tilde{t}\right)}{d\tilde{t}}\frac{d\tilde{t}}{d\gamma}+\frac{d}{d\gamma}\ln\left(1+\frac{\beta\gamma p}{1-\beta t_{22}}\left(\frac{\tau_2}{\tau_m}\right)^{-\sigma}\right)\right) \\
&= \frac{1}{\sigma-1}\left(\left(\beta/\left(1-\beta\tilde{t}\right)\right)p\left(\frac{\beta t_{2m}}{1-\beta t_{22}}-1\right)+\frac{\beta p}{1-\beta t_{22}}\left(\frac{\tau_2}{\tau_m}\right)^{-\sigma}/\left(1+\frac{\beta\gamma p}{1-\beta t_{22}}\left(\frac{\tau_2}{\tau_m}\right)^{-\sigma}\right)\right) \\
&= \frac{1}{\sigma-1}\left(-\frac{\beta p}{\left(1-\beta\tilde{t}\right)}\left(\frac{1-\beta}{1-\beta t_{22}}\right)+\frac{\beta p}{1-\beta t_{22}}\left(\frac{\tau_2}{\tau_m}\right)^{-\sigma}/\left(1+\frac{\beta\gamma p}{1-\beta t_{22}}\left(\frac{\tau_2}{\tau_m}\right)^{-\sigma}\right)\right) \\
&= \frac{1}{\sigma-1}\frac{\beta p}{1-\beta t_{22}}\left(-\left(\frac{1-\beta}{1-\beta\tilde{t}}\right)+\left(\frac{\tau_2}{\tau_m}\right)^{-\sigma}/\left(1+\frac{\beta\gamma p}{1-\beta t_{22}}\left(\frac{\tau_2}{\tau_m}\right)^{-\sigma}\right)\right)
\end{aligned}$$

where the third line uses $\tilde{t}\equiv t_{mm}+t_{m0}+t_{m2}\frac{\beta t_{2m}}{1-\beta t_{22}}=1-\gamma+\gamma\left(1-p\right)+\gamma p\frac{\beta t_{2m}}{1-\beta t_{22}}$

Note that around $\gamma=0$ we have $\frac{d\ln c_m^U}{d\gamma}|_{\gamma=0}=\frac{1}{\sigma-1}\frac{\beta p}{1-\beta t_{22}}\left(\left(\frac{\tau_2}{\tau_m}\right)^{-\sigma}-1\right)<0$. The inequality holds for all γ

$$\begin{aligned}
\frac{d\ln c_m^U}{d\gamma} &< 0 \\
\left(\frac{\tau_2}{\tau_m}\right)^{-\sigma} &< \left(1+\frac{\beta\gamma p}{1-\beta t_{22}}\left(\frac{\tau_2}{\tau_m}\right)^{-\sigma}\right)\left(\frac{1-\beta}{1-\beta\tilde{t}}\right) \\
\left(\frac{\tau_2}{\tau_m}\right)^{-\sigma}\left(1-\frac{\beta\gamma p}{\left(1-\beta t_{22}\right)}\left(\frac{1-\beta}{1-\beta\tilde{t}}\right)\right) &< \left(\frac{1-\beta}{1-\beta\tilde{t}}\right) \\
\left(\frac{\tau_2}{\tau_m}\right)^{-\sigma}\left[\left(1-\beta t_{22}\right)\left(1-\beta\tilde{t}\right)-\beta t_{m2}\left(1-\beta\right)\right] &< \left(1-\beta\right)\left(1-\beta t_{22}\right)
\end{aligned}$$

This holds because $\left(\frac{\tau_2}{\tau_m}\right)^{-\sigma}<1$ and the term in brackets on the LHS simplifies to the term on the RHS, $\left(1-\beta\right)\left(1-\beta t_{22}\right)$, after we use the definition for $\tilde{t}$ as well as $t_{2m}=1-t_{22}$.

Ordering of cutoffs:

We now prove $c_m^U = c_m^D U_m < c_m^D$, i.e. $U_m < 1$ if $t_{m2} > 0$ and $\frac{\tau_2}{\tau_m} > 1$

More generally we show the following ordering of cutoffs

$$c_2^U = c_2^D < c_m^U < c_m^D \leq c_0^U = c_0^D$$

where last equality is true if $t_{0m} = 0$

1. $c_m^D \leq c_0^U = c_0^D$ is obvious given that tariffs are lower (or no higher) under $s = 0$ than $s = m$
2. $c_m^U < c_m^D$ if $t_{m2} > 0$ and $\frac{\tau_2}{\tau_m} > 1$ ($U_m < 1$)

$$c_m^U = c_m^D U_m < c_m^D$$

$$U_m = \left[\frac{1-\beta}{1-\beta\tilde{t}}\left(1 + \frac{\beta t_{m2}}{1-\beta t_{22}}\left(\frac{\tau_2}{\tau_m}\right)^{-\sigma}\right)\right]^{\frac{1}{\sigma-1}} < 1$$

$$\left[(1-\beta)\frac{\beta t_{m2}}{1-\beta t_{22}}\right]\left(\frac{\tau_2}{\tau_m}\right)^{-\sigma} < 1 - \beta\tilde{t} - (1-\beta)$$

This inequality holds because $\left(\frac{\tau_2}{\tau_m}\right)^{-\sigma} < 1$ and the term in brackets on the LHS simplifies to the term on the RHS after we use the definition for $\tilde{t}$ as well as $t_{2m} = 1 - t_{22}$.

3. $c_2^U = c_2^D < c_m^U$

$$c_2^U = c_2^D = \left[\frac{a_2}{(1-\beta)K}\right]^{\frac{1}{\sigma-1}} < c_m^D \left[\frac{(1-\beta)(1-\beta t_{22}) + (1-\beta)\beta t_{m2}\left(\frac{\tau_2}{\tau_m}\right)^{-\sigma}}{\left(1-\beta\tilde{t}\right)(1-\beta t_{22})}\right]^{\frac{1}{\sigma-1}}$$

$$\left[\frac{a_2}{(1-\beta)K}\right]^{\frac{1}{\sigma-1}} < \left[\frac{a_m}{(1-\beta)K}\right]^{\frac{1}{\sigma-1}} \left[\frac{(1-\beta)(1-\beta t_{22}) + (1-\beta)\beta t_{m2}\left(\frac{\tau_2}{\tau_m}\right)^{-\sigma}}{\left(1-\beta\tilde{t}\right)(1-\beta t_{22})}\right]^{\frac{1}{\sigma-1}}$$

$$\left(\frac{\tau_2}{\tau_m}\right)^{-\sigma} < \frac{(1-\beta)(1-\beta t_{22}) + (1-\beta)\beta t_{m2}\left(\frac{\tau_2}{\tau_m}\right)^{-\sigma}}{\left(1-\beta\tilde{t}\right)(1-\beta t_{22})}$$

$$\left(\frac{\tau_2}{\tau_m}\right)^{-\sigma}\left(1-\beta\tilde{t}\right)(1-\beta t_{22}) < (1-\beta)(1-\beta t_{22}) + (1-\beta)\beta t_{m2}\left(\frac{\tau_2}{\tau_m}\right)^{-\sigma}$$

$$\left(\frac{\tau_2}{\tau_m}\right)^{-\sigma}\left[\left(1-\beta\tilde{t}\right)(1-\beta t_{22}) - (1-\beta)\beta t_{m2}\right] < (1-\beta)(1-\beta t_{22})$$

This inequality holds because $\left(\frac{\tau_2}{\tau_m}\right)^{-\sigma} < 1$ and the term in brackets on the LHS simplifies to the term on the RHS, $(1-\beta)(1-\beta t_{22})$, after we use the definition for $\tilde{t}$ as well as $t_{2m} = 1 - t_{22}$.

A.2 Technological upgrade threshold

In this appendix we provide the details for deriving the upgrade thresholds presented in section 2.3.

Derivation of $\Pi_w(a_s, c, z)$.

For $s = 0$ if it is not optimal to upgrade then the firm obtains $\pi(a_0, c)$ today and for all future periods since conditions can't improve, therefore it is equal to the expected value of exporting at the original technology

$$\Pi_w(a_0, c, z) = \Pi_e(a_0, c) \tag{47}$$

for the remaining states we have $\Pi_w(a_m, c, z)$, given by (22) in the text and for $s = 2$ we have the following for $c \in [c^U_{2z}, c^U_{mz}]$

$$\begin{aligned} \Pi_w(a_2, c, z) &= \pi(a_2, c) + \beta \left[t_{22} \Pi_w(a_2, c, z) + t_{2m} \left[\Pi_e(a_m, zc) - K_z \right] \right] \\ \Pi_w(a_2, c, z) \left(1 - \beta t_{22}\right) &= \pi(a_2, c) + \beta t_{2m} \left[\Pi_e(a_m, zc) - K_z \right] \end{aligned} \tag{48}$$

Reduced form of $\Pi_w(a_m, c, z)$

Use (22) and (48) and (21) to obtain

$$\begin{aligned} \Pi_w(a_m, c^U_{mz}, z) \left(1 - \beta t_{mm}\right) &= \pi(a_m, c^U_{mz}) \\ &\quad + \beta \left[\frac{t_{m2}}{1 - \beta t_{22}} \left[\pi(a_2, c^U_{mz}) + \beta t_{2m} \left[\Pi_e(a_m, z c^U_{mz}) - K_z \right] \right] + t_{m0} \left[z^{1-\sigma} \Pi_e(a_0, c^U_{mz}) - K_z \right] \right] \\ \Pi_w(a_m, c^U_{mz}, z) \left(1 - \beta \hat{t}\right) &= \pi(a_m, c^U_{mz}) \\ &\quad + \beta \left[\frac{t_{m2}}{1 - \beta t_{22}} \pi(a_2, c^U_{mz}) + t_{m0} \left[z^{1-\sigma} \frac{\pi(a_0, c) + \beta t_{0m} \Pi_e(a_m, c)}{1 - \beta t_{00}} - K_z \right] \right] \end{aligned}$$

where $\hat{t} \equiv t_{mm} + \beta t_{m2} \frac{t_{2m}}{1 - \beta t_{22}}$.

MFN cutoff derivation (c^U_{mz})

$$z^{1-\sigma} \Pi_e(a_m, c^U_{mz}) - K_z = \Pi_w(a_m, c^U_{mz}, z)$$

$$\left[z^{1-\sigma} \Pi_e(a_m, c^U_{mz}) - K_z \right] \left(1 - \beta \hat{t}\right) = \pi(a_m, c^U_{mz}) + \beta \left[\frac{t_{m2}}{1 - \beta t_{22}} \pi(a_2, c^U_{mz}) + t_{m0} \left[z^{1-\sigma} \frac{\pi(a_0, c^U_{mz}) + \beta t_{0m} \Pi_e(a_m, c^U_{mz})}{1 - \beta t_{00}} - K_z \right] \right]$$

$$z^{1-\sigma} \Pi_e(a_m, c^U_{mz}) \left(1 - \beta t_m\right) = \pi(a_m, c^U_{mz}) + \beta \left[\frac{t_{m2}}{1 - \beta t_{22}} \pi(a_2, c^U_{mz}) + \frac{t_{m0} z^{1-\sigma} \pi(a_0, c^U_{mz})}{1 - \beta t_{00}} \right] - \left(\beta t_{m0} - \left(1 - \beta \hat{t}\right) \right) K_z$$

$$\begin{aligned} z^{1-\sigma} \left(\pi(a_m, c^U_{mz}) + \beta \Sigma_{s \neq m} t_{ms} \frac{\pi(a_s, c^U_{mz})}{1 - \beta t_{ss}} \right) &= \pi(a_m, c^U_{mz}) + \beta \left[\frac{t_{m2}}{1 - \beta t_{22}} \pi(a_2, c^U_{mz}) + \frac{t_{m0} z^{1-\sigma} \pi(a_0, c^U_{mz})}{1 - \beta t_{00}} \right] + \left(1 - \beta \tilde{t}\right) K_z \\ \left(z^{1-\sigma} - 1\right) \left(\pi(a_m, c^U_{mz}) + \beta t_{m2} \frac{\pi(a_2, c^U_{mz})}{1 - \beta t_{22}} \right) &= \left(1 - \beta \tilde{t}\right) K_z \end{aligned}$$

where 4th line uses $t_m \equiv t_{mm} + \beta \left[t_{m0} \frac{t_{0m}}{1 - \beta t_{00}} + t_{m2} \frac{t_{2m}}{1 - \beta t_{22}} \right]$ from (9) and $\tilde{t} \equiv t_{mm} + t_{m0} + t_{m2} \frac{\beta t_{2m}}{1 - \beta t_{22}}$.

Solving for cutoff, we factor c and re-arrange

$$\left(z^{1-\sigma}-1\right)\left(1+\frac{\beta t_{m2}}{1-\beta t_{22}}\frac{a_2}{a_m}\right)a_m\left(c_{mz}^U\right)^{1-\sigma}=\left(1-\beta\tilde{t}\right)K_z$$

$$c_{mz}^U=\left[\left(1+\frac{\beta t_{m2}}{1-\beta t_{22}}\frac{a_2}{a_m}\right)\frac{a_m\left(z^{1-\sigma}-1\right)}{\left(1-\beta\tilde{t}\right)K_z}\right]^{\frac{1}{\sigma-1}}$$

$$c_{mz}^U=\left[\frac{1-\beta}{1-\beta\tilde{t}}\left(1+\frac{\beta t_{m2}}{1-\beta t_{22}}\left(\frac{\tau_2}{\tau_m}\right)^{-\sigma}\right)\right]^{\frac{1}{\sigma-1}}c_{mz}^D$$

$$c_{mz}^U=U_m c_{mz}^D$$

Worst case upgrade cutoff (c_{2z}^U)

Using the cutoff condition (20) and evaluating at the equilibrium value of exporting for the marginal upgrader at $s=2$ (21) and value of waiting in (48) we obtain

$$z^{1-\sigma}\Pi_e(a_2,c_{2z}^U)-K_z=\Pi_w(a_2,c_{2z}^U,z)$$

$$\left[z^{1-\sigma}\left(\frac{\pi(a_2,c_{2z}^U)+\beta t_{2m}\Pi_e(a_m,c_{2z}^U)}{1-\beta t_{22}}\right)-K_z\right](1-\beta t_{22})=\pi(a_2,c_{2z}^U)+\beta t_{2m}\left[z^{1-\sigma}\Pi_e(a_m,c_{2z}^U)-K_z\right]$$

$$z^{1-\sigma}\pi(a_2,c_{2z}^U)=\pi(a_2,c_{2z}^U)-\left(\beta t_{2m}-(1-\beta t_{22})\right)K_z$$

$$\pi(a_2,c_{2z}^U)\left(z^{1-\sigma}-1\right)=(1-\beta)K_z$$

$$c_{2z}^U=\left[\frac{a_2\left(z^{1-\sigma}-1\right)}{(1-\beta)K_z}\right]^{\frac{1}{\sigma-1}}=c_{2z}^D$$

where the second line uses (8) and the third one uses $t_{2m}+t_{22}=1$.

Agreement cutoff (c_{0z}^U)

Using the cutoff condition (20) along with (21) and (47) we obtain

$$z^{1-\sigma}\Pi_e(a_0,c_{0z}^U)-K_z=\Pi_e(a_0,c)$$

$$\left(z^{1-\sigma}-1\right)\Pi_e(a_0,c_{0z}^U)=K_z$$

$$\left(z^{1-\sigma}-1\right)\left[\pi(a_0,c_{0z}^U)+\beta t_{0m}\left(\frac{\pi(a_m,c_{0z}^U)}{1-\beta t_m}+\frac{\beta}{1-\beta t_m}t_{m0}\frac{\pi(a_0,c_{0z}^U)}{1-\beta t_{00}}+\frac{\beta}{1-\beta t_m}t_{m2}\frac{\pi(a_2,c_{0z}^U)}{1-\beta t_{22}}\right)\right]=K_z\left(1-\beta t_{00}\right)$$

where the third line uses (8) and (9). We can factor out the cost and solve the general expression above in the same way we did for the entry cutoff to obtain

$$c_{0z}^U=U_0 c_{0z}^D \tag{49}$$

where U_0 is given as before

$$U_0=\left[\frac{1-\beta}{1-\beta t_{00}}\left(1+\frac{\beta t_{0m}}{1-\beta t_m}\left(\beta t_{m0}+\left(\frac{\tau_m}{\tau_0}\right)^{-\sigma}\left(1+\frac{\beta t_{m2}}{1-\beta t_{22}}\left(\frac{\tau_2}{\tau_m}\right)^{-\sigma}\right)\right)\right)\right]^{\frac{1}{\sigma-1}} \tag{50}$$

Note that if no exit from the agreement is expected ($t_{00}=1=1-t_{0m}$) then $U_0=1$ as we note in the

text and so

$$c_{0z}^{U}|_{t_{00}=1} = \left[\frac{a_0\left(z^{1-\sigma}-1\right)}{(1-\beta)K_z}\right]^{\frac{1}{\sigma-1}} = c_{0z}^{D}$$

Sufficient condition for $c_{0z}^{U}(\phi) < c_2^U$

As we note in the text this will ensure that the marginal entrant into exporting in any state will never upgrade in any state so the entry cutoffs are unaffected by the possibility of upgrading. This requires

$$\begin{aligned} c_{0z}^{U} &< c_2^U \\ U_0\left[\frac{a_0\left(z^{1-\sigma}-1\right)}{(1-\beta)K_z}\right]^{\frac{1}{\sigma-1}} &< \left[\frac{a_2}{(1-\beta)K}\right]^{\frac{1}{\sigma-1}} \\ \phi < \left[\frac{a_2}{a_0}\right]^{\frac{1}{\sigma-1}}/U_0 &= \left[\frac{\tau_2}{\tau_0}\right]^{\frac{-\sigma}{\sigma-1}}/U_0 \end{aligned}$$

So if the agreement is absorbing (so $U_0 = 1$) we can see that the condition is simply that the upgrading parameter ϕ is sufficiently small or $\left(z^{1-\sigma}-1\right)\frac{K}{K_z} < \left(\frac{\tau_2}{\tau_0}\right)^{-\sigma}$.

A.3 Entry threshold (general equilibrium)

Deriving $c_{2T}^{U} = c_{2T}^{D}$

Under $s = 2$ a firm that is indifferent between entering at T or waiting will enter the following period if it survives either because the tariff state improves or because the aggregate conditions improve. Thus for all $T \geq 0$ the value of waiting and exporting are respectively

$$\Pi_w(a_{2T}, c_{2T}^U) = 0 + \beta\left[t_{22}\Pi_e(a_{2T+1}, c_{2T}^U) + t_{2m}\Pi_e(a_m, c_{2T}^U) - K\right] \tag{51}$$

$$\Pi_e(a_{2T}, c) = \pi(a_{2T}, c) + \beta\left[t_{22}\Pi_e(a_{2T+1}, c) + t_{2m}\Pi_e(a_m, c)\right] \tag{52}$$

Thus a firm is indifferent between the two when $\Pi_e(a_{2T}, c_{2T}^U) - K = \Pi_w(a_{2T}, c_{2T}^U)$, which yields $\pi(a_{2T}, c) = (1-\beta)K$ and therefore $c_{2T}^U = c_{2T}^D$.

Deriving c_{mT}^{U}

The functional forms for the expected value of export is the same as in the baseline (7) and that is also the case for the value of waiting, given by (12). The difference is that now the expressions for the expected values of export and wait under $s = 2$ are different due to transition dynamics. More specifically, we require

$$\begin{aligned} \Pi_e(a_{2T=0}, c) &= \pi(a_{2T=0}, c) + \beta\left[t_{22}\Pi_e(a_{2T=1}, c) + t_{2m}\Pi_e(a_m, c)\right] \\ &= \Sigma_{t=0}^{\infty}\left(\beta t_{22}\right)^t \pi(a_{2t}, c) + \frac{\beta t_{2m}}{1-\beta t_{22}}\Pi_e(a_m, c) \end{aligned}$$

where the second line uses the fact that (52) holds for all T and solves it forward.

For the value of waiting we use the fact that a firm that is indifferent between entering at MFN will never want to enter under column 2, independently of how long ago the shock occurred to obtain

$$\begin{aligned} \Pi_w(a_{2T=0}, c_m^U) &= 0 + \beta\left[t_{22}\Pi_w(a_{2T=1}, c_m^U) + t_{2m}\Pi_w(a_m, c_m^U)\right] \\ &= \frac{\beta t_{2m}}{1-\beta t_{22}}\Pi_w(a_m, c_m^U) \end{aligned}$$

Replacing $\Pi_e(a_{2T=0}, c)$ in (7) and $\Pi_w(a_{2T=0}, c_m^U)$ in (12) we obtain respectively

$$\Pi_e(a_m, c) = \pi(a_m, c) + \beta \left[t_{m0}\Pi_e(a_0, c) + t_{mm}\Pi_e(a_m, c) + t_{m2}\Sigma_{t=0}^{\infty} \left(\beta t_{22}\right)^t \pi(a_{2t}, c) + \frac{\beta t_{2m}}{1-\beta t_{22}}\Pi_e(a_m, c) \right]$$

$$\Pi_e(a_m, c) = \frac{1}{1-\beta\left(\tilde{t} - t_{m0}\right)} \{ \pi(a_m, c) + \beta \left[t_{m0}\Pi_e(a_0, c) + t_{m2}\Sigma_{t=0}^{\infty} \left(\beta t_{22}\right)^t \pi(a_{2t}, c) \right] \} \tag{53}$$

$$\begin{aligned} \Pi_w(a_m, c_m^U) &= \beta \left[t_{m0} \left[\Pi_e(a_0, c_m^U) - K \right] + t_{mm}\Pi_w(a_m, c_m^U) + t_{m2}\frac{\beta t_{2m}}{1-\beta t_{22}}\Pi_w(a_m, c_m^U) \right] \\ &= \frac{\beta t_{m0}}{1-\beta\left(\tilde{t} - t_{m0}\right)} \left[\Pi_e(a_0, c_m^U) - K \right] \end{aligned}$$

where $\tilde{t} \equiv t_{m0} + t_{mm} + t_{m2}\frac{\beta t_{2m}}{1-\beta t_{22}}$

Using the indifference condition, simplifying and solving for c_m^U we have

$$\begin{aligned} \Pi_e(a_m, c_m^U) - K &= \Pi_w(a_m, c_m^U) \\ \pi(a_m, c) + \beta \left[t_{m0}\Pi_e(a_0, c) + t_{m2}\Sigma_{t=0}^{\infty} \left(\beta t_{22}\right)^t \pi(a_{2t}, c) \right] - K\left(1 - \beta\left(\tilde{t} - t_{m0}\right)\right) &= \left[t_{m0} \left[\Pi_e(a_0, c_m^U) - K \right] \right] \\ \pi(a_m, c) + \beta \left[t_{m2}\Sigma_{t=0}^{\infty} \left(\beta t_{22}\right)^t \pi(a_{2t}, c) \right] &= \left(1 - \beta\tilde{t}\right) K \\ a_m \left[1 + \beta t_{m2}\frac{\Sigma_{t=0}^{\infty} \left(\beta t_{22}\right)^t a_{2t}}{a_m} \right] c^{1-\sigma} &= \left(1 - \beta\tilde{t}\right) K \\ \frac{a_m}{(1-\beta)K}\frac{(1-\beta)}{\left(1-\beta\tilde{t}\right)} \left[1 + \frac{\beta t_{m2}}{1-\beta}\frac{\Sigma_{t=0}^{\infty} \left(\beta t_{22}\right)^t a_{2t}}{\Sigma_{t=0}^{\infty}\beta^t a_m} \right] &= c^{\sigma-1} \\ \left[\frac{a_m^D}{(1-\beta)K} \right]^{\frac{1}{\sigma-1}} \left[\frac{a_m}{a_m^D} \right]^{\frac{1}{\sigma-1}} U_m\left(\tilde{\omega}\right) &= c_m^U \\ c_m^U &= c_m^D \frac{P_m}{P_m^D} U_m\left(\tilde{\omega}\right) \end{aligned}$$

where

$$U_m\left(\tilde{\omega}\right) = \left[\frac{1-\beta}{1-\beta\tilde{t}} \left(1 + \frac{\beta t_{m2}}{1-\beta t_{22}}\tilde{\omega} \right) \right]^{\frac{1}{\sigma-1}}$$

Note that this expression is similar to the one we derived in the absence of GE effects (15). But the proportion of profits lost term is now $\tilde{\omega} = \left(\frac{\tau_2}{\tau_m}\right)^{-\sigma} \frac{(1-\beta t_{22})\Sigma_{t=0}^{\infty}(\beta t_{22})^t A_{2t}}{A_m}$

$\tilde{\omega} < 1$ **when direct effect dominates (28).**

$$\tilde{\omega} \equiv \left(\frac{\tau_2}{\tau_m}\right)^{-\sigma} \frac{\left(1-\beta t_{22}\right)\Sigma_{t=0}^{\infty}\left(\beta t_{22}\right)^t A_{2t}}{A_m} < 1 \Longleftrightarrow \left(1-\beta t_{22}\right)\Sigma_{t=0}^{\infty}\left(\beta t_{22}\right)^t \pi_{2t} < \pi_m$$

The equivalence is due to the profit definition. The inequality holds since $\pi_{2t} \leq \pi_2$ for all t (lower profits under transition than steady state) and $\left(1-\beta t_{22}\right)\Sigma_{t=0}^{\infty}\left(\beta t_{22}\right)^t \pi_2 = \pi_2 < \pi_m$ where the inequality holds whenever the direct effect dominates (given by condition in 28).

A.4 Technological upgrade threshold (general equilibrium)

Assume $c_{z0}^U < c_{2T=0}^U$ s.t. only the most productive will ever upgrade.

Price index now reflects upgrading and thus the equilibrium value of entry cutoffs change but their

functional form does not.

Continue to assume the profit ranking condition in (28) still holds, which requires only that we evaluate it using the relevant price index, which now reflects upgrading.

1. $c^U_{z2T} = \phi c^U_{2T}$.

Under $s = 2$ a firm that is indifferent between upgrading at T or waiting will upgrade the following period if it survives either because the tariff state improves or because the aggregate conditions improve. Thus for all $T \geq 0$ the value of waiting and upgrading are respectively

$$\Pi_w(a_{2T}, c^U_{z2T}, z) = \pi(a_{2T}, c) + \beta z^{1-\sigma}\left[t_{22}\Pi_e(a_{2T+1}, c^U_{z2T}) + t_{2m}\Pi_e(a_m, c^U_{z2T}) - K_z/z^{1-\sigma}\right] \tag{54}$$

$$z^{1-\sigma}\Pi_e(a_{2T}, c) = z^{1-\sigma}\pi(a_{2T}, c) + \beta z^{1-\sigma}\left[t_{22}\Pi_e(a_{2T+1}, c) + t_{2m}\Pi_e(a_m, c)\right] \tag{55}$$

Thus a firm is indifferent between the two when $z^{1-\sigma}\Pi_e(a_{2T}, c^U_{z2T}) - K_z = \Pi_w(a_{2T}, c^U_{z2T}, z)$, which yields $\left(z^{1-\sigma} - 1\right)\pi(a_{2T}, c^U_{z2T}) = (1-\beta)K_z$. Recall that the entry cutoff is implicitly defined by $\pi(a_{2T}, c^U_{2T}) = (1-\beta)K$ and therefore $c^U_{z2T} = \phi c^U_{2T}$ where ϕ is given by (19).

2. $c^U_{0z} = c^D_{0z} = \phi c^D_0$ **when** $t_{00} = 1$**.**

If the agreement is an absorbing state then c^U_{0z} is equal to the deterministic cutoff implicitly given by (17) when evaluated at the price index consistent with it.

3. $c^U_{mz} = \phi c^U_m$

$$z^{1-\sigma}\Pi_e(a_m, c^U_{zm}) - K_z = \Pi_w(a_m, c^U_{zm}, z)$$

where $\Pi_e(a_m, c^U_{zm})$ is given by (53), evaluated at the new equilibrium cutoff.

For the value of waiting we first use the fact that a firm that is indifferent between upgrading at MFN it will never want to upgrade under column 2, independently of how long ago the shock occurred to obtain

$$\begin{aligned}\Pi_w(a_{2T=0}, c^U_{zm}, z) &= \pi(a_{2T=0}, c^U_{zm}) + \beta\left[t_{22}\Pi_w(a_{2T=1}, c^U_{zm}, z) + t_{2m}\Pi_w(a_m, c^U_{zm}, z)\right] \\ &= \Sigma^\infty_{t=0}\left(\beta t_{22}\right)^t \pi(a_{2t},, c^U_{zm}) + \frac{\beta t_{2m}}{1-\beta t_{22}}\Pi_w(a_m, c^U_{zm}, z)\end{aligned}$$

which we replace in the value of waiting at MFN

$$\begin{aligned}\Pi_w(a_m, c^U_{zm}, z) &= \pi(a_m, c) + \beta\left[t_{m0}\left[z^{1-\sigma}\Pi_e(a_0, c^U_{zm}) - K_z\right] + t_{mm}\Pi_w(a_m, c^U_{zm}, z) + t_{m2}\Pi_w(a_{2T=0}, c^U_{zm}, z)\right] \\ &= \pi(a_m, c) + \beta\left[\begin{array}{c} t_{m0}\left[z^{1-\sigma}\Pi_e(a_0, c^U_{zm}) - K_z\right] + \left(t_{mm} + t_{m2}\frac{\beta t_{2m}}{1-\beta t_{22}}\right)\Pi_w(a_m, c^U_{zm}, z) \\ +t_{m2}\Sigma^\infty_{t=0}\left(\beta t_{22}\right)^t \pi(a_{2t}, c^U_{zm})\end{array}\right] \\ &= \left[\pi(a_m, c) + \beta t_{m0}\left(z^{1-\sigma}\Pi_e(a_0, c^U_{zm}) - K_z\right) + \beta t_{m2}\Sigma^\infty_{t=0}\left(\beta t_{22}\right)^t \pi(a_{2t}, c^U_{zm})\right] / \left(1 - \beta\left(\tilde{t} - t_{m0}\right)\right)\end{aligned}$$

Solving

$$\begin{aligned}&z^{1-\sigma}\{\pi(a_m, c) + \beta\left[t_{m0}\Pi_e(a_0, c) + t_{m2}\Sigma^\infty_{t=0}\left(\beta t_{22}\right)^t \pi(a_{2t}, c)\right]\} - K_z\left(1 - \beta\left(\tilde{t} - t_{m0}\right)\right) \\ &= \pi(a_m, c) + \beta t_{m0}\left(z^{1-\sigma}\Pi_e(a_0, c^U_{zm}) - K_z\right) + \beta t_{m2}\Sigma^\infty_{t=0}\left(\beta t_{22}\right)^t \pi(a_{2t}, c^U_{zm})\end{aligned}$$

$$\left(z^{1-\sigma}-1\right)\left(\pi(a_m,c)+\beta t_{m2}\Sigma_{t=0}^{\infty}\left(\beta t_{22}\right)^t\pi(a_{2t},c)\right)=\left(1-\beta\tilde{t}\right)K_z$$

$$a_m\left(z^{1-\sigma}-1\right)\left[1+\beta t_{m2}\frac{\Sigma_{t=0}^{\infty}\left(\beta t_{22}\right)^t a_{2t}}{a_m}\right]c^{1-\sigma}=\left(1-\beta\tilde{t}\right)K_z$$

$$\frac{a_m\left(z^{1-\sigma}-1\right)}{(1-\beta)K_z}\frac{(1-\beta)}{\left(1-\beta\tilde{t}\right)}\left[1+\frac{\beta t_{m2}}{1-\beta}\frac{\Sigma_{t=0}^{\infty}\left(\beta t_{22}\right)^t a_{2t}}{\Sigma_{t=0}^{\infty}\beta^t a_m}\right]=c^{\sigma-1}$$

$$\left[\frac{a_m^D\left(z^{1-\sigma}-1\right)}{(1-\beta)K_z}\right]^{\frac{1}{\sigma-1}}\left[\frac{a_m}{a_m^D}\right]^{\frac{1}{\sigma-1}}U_m\left(\tilde{\omega}\right)=c_m^U$$

$$\phi\left[\frac{a_m^D}{(1-\beta)K}\right]^{\frac{1}{\sigma-1}}\left[\frac{a_m}{a_m^D}\right]^{\frac{1}{\sigma-1}}U_m\left(\tilde{\omega}\right)=c_m^U$$

$$c_{mz}^U=\phi c_m^D\frac{P_m}{P_m^D}U_m\left(\tilde{\omega}\right)$$

$$c_{mz}^U=\phi c_m^U\left(\tilde{\omega}\right)$$

where $U_m\left(\tilde{\omega}\right)$ is the same expression we found for (31). so $\tilde{\omega}=\left(\frac{\tau_2}{\tau_m}\right)^{-\sigma}\frac{(1-\beta t_{22})\Sigma_{t=0}^{\infty}(\beta t_{22})^t A_{2t}}{A_m}<1$ when direct effect dominates (28), as shown in the previous section of the Appendix.

A.5 Comparative statics (general equilibrium)

A.5.1 Effect of trade costs on firm entry and price index

Here we derive the impact of tariffs and transport costs on the price index and firm entry. These are used in the quantification section to provide an upper bound for the term g and to calculate the price effect of tariffs and transport cost to include in the GE advalorem equivalent of uncertainty calculation.

Recall that $g\equiv\frac{(1-\beta t_{22})\Sigma_{t=0}^{\infty}(\beta t_{22})^t A_{2t}}{A_m}\leq\left(\frac{P_2^D}{P_m^D}\right)^{\sigma-1}$ so $g\leq\exp\left((\sigma-1)\ln\frac{P_2^D}{P_m^D}\right)$. So we first provide a linear approximation to the growth in the deterministic price index due to the change in tariffs from MFN to column 2. We do so in the absence of upgrading and then argue that the expression is similar with upgrading (when written as a function of export shares, which will reflect any upgrading). This is explicitly shown in section A.5.3 when deriving the elasticities of P wrt cutoffs. A similar argument to the one in that section can be applied here.

Recall that we have an implicit solution to the system of $V+1$ equations $P\left(\mathbf{c}^D,\tau\right)$ and $c_V\left(P^D,\tau_V\right)$ for each V so the total change due to the tariff can be found as follows

$$\begin{aligned}d\ln P\left(\mathbf{c}^D,\tau\right)&=\Sigma_V\frac{\partial\ln P\left(\mathbf{c}^D,\tau\right)}{\partial\ln c_V^D}d\ln c_V^D+\Sigma_V\frac{\partial\ln P\left(\mathbf{c}^D,\tau\right)}{\partial\ln\tau_V}d\ln\tau_V\\&=\frac{k-\sigma+1}{(1-\sigma)}I\Sigma_V\frac{\tau_V R_V}{\Sigma_V\tau_V R_V}d\ln c_V^D+I\Sigma_V\frac{\tau_V R_V}{\Sigma_V\tau_V R_V}d\ln\tau_V\end{aligned}$$

where $I\equiv\Sigma_V\tau_V R_V/E$. Below we derive the two partial elasticities used in the second line as follows. Denote Ω_{VC} as the set of varieties in industry V produced by firms in country $C=ch(ina),o(ther)$ so $\Omega=\cup_{VC}\Omega_{VC}$ and the price index, P can then be written as

$$P^{1-\sigma}=\int_{v\in\Omega}\left(p_v\right)^{1-\sigma}dv=\Sigma_{V,ch}\int_{v\in\Omega_{V,ch}}\left(p_v\right)^{1-\sigma}dv+\Sigma_{V,C\neq ch}\int_{v\in\Omega_{VC}}\left(p_v\right)^{1-\sigma}dv$$

Using the equilibrium price paid by consumers of imported goods, $p_v=(w_e\tau_V d_V c_v/\rho)$, and the Pareto

distribution we then obtain $\frac{\partial \ln P\left(\mathbf{c}_V^D(\tau),\tau\right)}{\partial \ln c_V^D(\tau)}$ as follows

$$\begin{aligned}
\frac{\partial \ln P\left(c^D(\tau),\tau\right)}{\partial \ln c_V^D} &= \frac{1}{1-\sigma}\partial \ln\left[\Sigma_{V,ch}\frac{N_V}{c_V^k}\int_0^{c_V^D}\left(\left(w_e d_V/\rho\right)\tau_V\right)^{1-\sigma}k\left(c_v\right)^{k-\sigma}dc+\Sigma_{V,C\neq china}\int_{v\in\Omega_{VC}}\left(p_v\right)^{1-\sigma}dv\right]/\partial \ln c_V^D \\
&= \frac{1}{1-\sigma}\frac{c_V^D}{P^{1-\sigma}}\partial\left[\Sigma_{V,ch}\frac{N_V}{c_V^k}\int_0^{c_V^D}\left(\left(w_e d_V/\rho\right)\tau_V\right)^{1-\sigma}k\left(c_v\right)^{k-\sigma}dc\right]/\partial c_V^D \\
&= \frac{1}{1-\sigma}\frac{c_V^D}{P^{1-\sigma}}\left[\left(\left(w_e d_V/\rho\right)\tau_V\right)^{1-\sigma}\frac{N_V}{c_V^k}k\left(c_V^D\right)^{k-\sigma}\right] \\
&= \frac{1}{1-\sigma}\left[\tau_V k\left(\left(\left(w_e/(P\rho)\right)d_V\right)^{1-\sigma}\tau_V^{-\sigma}\frac{N_V}{c_V^k}\left(c_V^D\right)^{k-\sigma+1}\right]\right. \\
&= \frac{1}{1-\sigma}\left[\tau_V\frac{R_V}{\frac{1}{k-\sigma+1}E}\right] \\
&= \frac{k-\sigma+1}{1-\sigma}\frac{\tau_V R_V}{E}
\end{aligned}$$

The partial tariff elasticity, $\frac{\partial \ln P\left(\mathbf{c}^D,\tau\right)}{\partial \ln \tau_V}|_{\tau_m}$, is obtained as follows

$$\begin{aligned}
\frac{\partial \ln P\left(c^D,\tau\right)}{\partial \ln \tau_V} &= \frac{1}{1-\sigma}\partial \ln\left[\Sigma_{V,ch}N_V\int_0^{c_1^D}\left(\left(w_e d_V c_v/\rho\right)\tau_V\right)^{1-\sigma}dG+\Sigma_{V,C\neq china}\int_{v\in\Omega_{VC}}\left(p_v\right)^{1-\sigma}dv\right]/\partial \ln \tau_V \\
&= \frac{1}{1-\sigma}\frac{\tau_{Vm}}{P_m^{1-\sigma}}\partial\left[\Sigma_{V,ch}N_V\int_0^{c_1^D}\left(\left(w_e d_V c_v/\rho\right)\tau_V\right)^{1-\sigma}dG\right]/\partial \tau_{Vm} \\
&= \frac{1}{P_m^{1-\sigma}}N_V\int_0^{c_1^D}\left(\left(w_e d_V c_v/\rho\right)\tau_V\right)^{1-\sigma}dG \\
&= \tau_V N_V\left(\left(w_e d_V/P_m\rho\right)\right)^{1-\sigma}\tau_V^{-\sigma}\int_0^{c_1^D}\left(c_v\right)^{1-\sigma}dG \\
&= \tau_V\frac{a_{mV}}{E}\sigma N_V\int_0^{c_1^D}\left(c_v\right)^{1-\sigma}dG \\
&= \frac{\tau_V R_V}{E}
\end{aligned}$$

where $a=E\left(1-\rho\right)\left(w_e d/P\rho\right)^{1-\sigma}{\tau_{sV}}^{-\sigma}$ and $R_{tV}=a_{tV}\sigma N_V\int_0^{c_1^D}\left(c_v\right)^{1-\sigma}dG$

Weighted effect of tariff on cutoff

$$\begin{aligned}
d\ln c_V\left(P^D,\tau_V\right) &= \frac{\partial \ln c_V\left(P^D,\tau_V\right)}{\partial \ln \tau_V}d\ln\tau_V+\frac{\partial \ln c_V\left(P^D,\tau_V\right)}{\partial \ln P^D}d\ln P \\
I\Sigma_V\frac{\tau_V R_V}{\Sigma_V\tau_V R_V}d\ln c_V\left(P^D,\tau_V\right) &= \frac{-\sigma}{\sigma-1}I\Sigma_V\frac{\tau_V R_V}{\Sigma_V\tau_V R_V}d\ln\tau_V+Id\ln P
\end{aligned}$$

Impact of tariffs on P

Replacing the cutoff effect above in the price expression and simplifying

$$d\ln P\left(\mathbf{c}^D,\tau\right)=\frac{k-\sigma+1}{(1-\sigma)}\left(\frac{-\sigma}{\sigma-1}I\Sigma_V\frac{\tau_V R_V}{\Sigma_V\tau_V R_V}d\ln\tau_V+Id\ln P\right)+I\Sigma_V\frac{\tau_V R_V}{\Sigma_V\tau_V R_V}d\ln\tau_V$$

$$d\ln P\left(\mathbf{c}^D,\tau\right)\left[1-I\frac{k-\sigma+1}{(1-\sigma)}\right]=\frac{k-\sigma+1}{(1-\sigma)}\left(\frac{-\sigma}{\sigma-1}I\Sigma_V\frac{\tau_V R_V}{\Sigma_V\tau_V R_V}d\ln\tau_V\right)+I\Sigma_V\frac{\tau_V R_V}{\Sigma_V\tau_V R_V}d\ln\tau_V$$

$$d\ln P\left(\mathbf{c}^D,\tau\right)=\left[\left(\frac{-\sigma}{\sigma-1}\right)\frac{k-\sigma+1}{(1-\sigma)}+1\right]\frac{I}{1-I\frac{k-\sigma+1}{(1-\sigma)}}\Sigma_V\frac{\tau_{mV}R_{mV}}{\Sigma_V\tau_{mV}R_{mV}}d\ln\tau_V$$

If we evaluated the change starting at the MFN values and increasing to column 2 we obtain

$$d\ln P\left(\mathbf{c}^D\left(\tau\right),\tau\right)|_{\tau_m}=\left[\frac{\frac{\sigma}{\sigma-1}\left(k-\sigma+1\right)+\sigma-1}{\left(k-\sigma+1\right)I+\sigma-1}\right]I\Sigma_V\frac{\tau_{mV}R_{mV}}{\Sigma_V\tau_{mV}R_{mV}}\ln\frac{\tau_{2V}}{\tau_{mV}}$$

Impact of transport cost on P

This can be similarly found if we note that $\frac{\partial\ln P\left(c^D,\tau\right)}{\partial\ln\tau_V}=\frac{\partial\ln P\left(c^D,\tau\right)}{\partial\ln d_V}$ and $d\ln c_V\left(P^D,d_V\right)|_\tau=-d\ln d_V+d\ln P$, so

$$d\ln P\left(\mathbf{c}^D,\tau,\mathbf{d}\right)=\frac{k-\sigma+1}{(1-\sigma)}\left(-I\Sigma_V\frac{\tau_V R_V}{\Sigma_V\tau_V R_V}d\ln d_V+Id\ln P\right)+I\Sigma_V\frac{\tau_V R_V}{\Sigma_V\tau_V R_V}d\ln d_V$$

$$d\ln P\left(\mathbf{c}^D,\tau,\mathbf{d}\right)\left[1-I\frac{k-\sigma+1}{(1-\sigma)}\right]=\left(I\Sigma_V\frac{\tau_V R_V}{\Sigma_V\tau_V R_V}d\ln d_V\right)\frac{k}{\sigma-1}$$

$$d\ln P\left(\mathbf{c}^D,\tau,\mathbf{d}\right)=\left[\frac{k}{\left(k-\sigma+1\right)I+\left(\sigma-1\right)}\right]I\Sigma_V\frac{\tau_V R_V}{\Sigma_V\tau_V R_V}d\ln d_V$$

A.5.2 Effect of policy uncertainty on firm entry and price index

In equation (35) we provide the semi-elasticity of the price index wrt γ as a function of $\varepsilon_V\equiv\partial\ln P\left(\mathbf{c}\right)/\partial\ln c_V^U$. We now show that this is similar to the deterministic elasticity derived in the last section and then use it to to obtain the relationship between the price index and γ in terms of deep parameters and data. We first do so in the absence of upgrading and then show that the expression is similar with upgrading (when written as a function of export shares, which will reflect any upgrading). We also use the expression to evaluate the general equilibrium impact of changes in uncertainty on entry.

Denote Ω_{VC} as the set of varieties in industry V produced by firms in country $C=ch(ina),o(ther)$ so $\Omega=\cup_{VC}\Omega_{VC}$ and the price index, P can then be written as

$$P^{1-\sigma}=\int_{v\in\Omega}\left(p_v\right)^{1-\sigma}dv=\Sigma_{V,ch}\int_{v\in\Omega_{V,ch}}\left(p_v\right)^{1-\sigma}dv+\Sigma_{V,C\neq ch}\int_{v\in\Omega_{VC}}\left(p_v\right)^{1-\sigma}dv$$

Using the equilibrium price paid by consumers of imported goods, $p_v=\left(w_e\tau_V d_V c_v/\rho\right)$, and the Pareto distribution we then obtain ε_V as follows

$$\begin{aligned}\frac{\partial\ln P\left(\mathbf{c}\right)}{\partial\ln c_V^U}&=\left(1-\sigma\right)^{-1}\partial\ln\left[\Sigma_{V,ch}\frac{N_V}{c_V^k}\int_0^{c_V^U}\left(w_e\tau_V d_V/\rho\right)^{1-\sigma}k\left(c_v\right)^{k-\sigma}dc+\Sigma_{V,C\neq ch}\int_{v\in\Omega_{VC}}\left(p_v\right)^{1-\sigma}dv\right]/\partial\ln c_V^U\\&=\left(1-\sigma\right)^{-1}\frac{c_V^U}{P^{1-\sigma}}\partial\left[\Sigma_{V,ch}\frac{N_V}{c_V^k}\int_0^{c_V^U}\left(w_e\tau_V d_V/\rho\right)^{1-\sigma}k\left(c_v\right)^{k-\sigma}dc\right]/\partial c_V^U\\&=\left(1-\sigma\right)^{-1}\frac{c_V^U}{P^{1-\sigma}}\left[\left(w_e\tau_V d_V/\rho\right)^{1-\sigma}\frac{N_V}{c_V^k}k\left(c_V^U\right)^{k-\sigma}\right]\\&=\left(1-\sigma\right)^{-1}\left[\tau_V k\left(d_V w_e/\left(P\rho\right)\right)^{1-\sigma}\tau_V^{-\sigma}\frac{N_V}{c_V^k}\left(c_V^U\right)^{k-\sigma+1}\right]\end{aligned}$$

where we can then use the equilibrium expression for exports below to obtain

$$\varepsilon_V \equiv \frac{\partial \ln P(\mathbf{c})}{\partial \ln c_V^U} = -\frac{k-\sigma+1}{\sigma-1}\frac{\tau_V R_V}{E} \tag{56}$$

$$R_V = \tau^{-\sigma} d_V^{1-\sigma} (c_V^U)^{k-\sigma+1} \frac{N_V}{c_V^k} \frac{k}{k-\sigma+1} \left(w_e/P\rho\right)^{1-\sigma} E$$
$$(k-\sigma+1)\frac{R_V}{E} = k \left(w_e/P\rho d_V\right)^{1-\sigma} \tau^{-\sigma} \frac{N_V}{c_V^k} (c_V^U)^{k-\sigma+1}$$

Semi-elasticity of P wrt γ

Using the expression for ε_V derived above in (35) and noting that $\tilde{\varepsilon}_V \equiv \frac{\varepsilon_V}{(1-\Sigma_V \varepsilon_V)}$ we obtain

$$\begin{aligned}
\left.\frac{d \ln P_m(\mathbf{c}_m)}{d\gamma}\right|_{\gamma=0} &= \frac{\beta p}{(\sigma-1)(1-\beta t_{22})} \Sigma_V \tilde{\varepsilon}_{Vm} (\tilde{\omega}_V - 1) \\
&= \frac{\beta p}{(\sigma-1)(1-\beta t_{22})} \Sigma_V \frac{\frac{k-\sigma+1}{(1-\sigma)} \frac{\tau_{Vm} R_{Vm}}{E}}{1 - \frac{k-\sigma+1}{(1-\sigma)} \frac{\Sigma_V \tau_{Vm} R_{Vm}}{E}} (\tilde{\omega}_{Vm} - 1) \\
&= \frac{\beta p}{(\sigma-1)(1-\beta t_{22})} \frac{(k-\sigma+1) I_m}{(k-\sigma+1) I_m + \sigma - 1} \Sigma_V r_{Vm} (1 - \tilde{\omega}_{Vm})
\end{aligned}$$

where $I_m \equiv \frac{\Sigma_V \tau_{Vm} R_{Vm}}{E}$ and the tariff inclusive import weights evaluated under the MFN state are defined as $r_{Vm} \equiv \frac{\tau_{Vm} R_{Vm}}{\Sigma_V \tau_{Vm} R_{Vm}}$. Thus a necessary and sufficient condition for $\left.\frac{d \ln P_m(\mathbf{c}_m)}{d\gamma}\right|_{\gamma=0} > 0$ is $\Sigma_V r_{Vm} (1 - \tilde{\omega}_V)|_{\gamma=0} > 0$.

Semi-elasticity of entry wrt γ

$$\begin{aligned}
\Sigma_V r_{Vm} \frac{d \ln c_{mV}^U}{d\gamma}|_{\gamma=0} &= \Sigma_V r_{Vm} \left[\frac{d \ln U_m(\tilde{\omega}_V)}{d\gamma} + \frac{d \ln P_m(\mathbf{c}_m)}{d\gamma}\right]\Big|_{\gamma=0} \\
&= \Sigma_V r_{Vm} \frac{\beta p}{(\sigma-1)(1-\beta t_{22})} (\tilde{\omega}_V - 1) + \frac{\beta p}{(\sigma-1)(1-\beta t_{22})} \frac{(k-\sigma+1) I}{(k-\sigma+1) I + \sigma - 1} \Sigma_V r_{Vm} (1 - \tilde{\omega}_V) \\
&= \left(1 - \frac{(k-\sigma+1) I_m}{(k-\sigma+1) I_m + \sigma - 1}\right) \frac{\beta p}{(\sigma-1)(1-\beta t_{22})} \Sigma_V r_{Vm} (\tilde{\omega}_V - 1)
\end{aligned}$$

A.5.3 Effect of policy uncertainty on upgrading and price index

Similarly to the derivation without upgrading we split the price index into the subcomponents depending on the country of origin and industry (1st line below). In the second line we further divide the foreign varieties in to the endogenous set of firms that upgrades ($\Omega_{V,ch}^{\tilde{z}}$), since they will have lower equilibrium prices and the remaining set of firms ($\Omega_{V,ch} \setminus \Omega_{V,ch}^{\tilde{z}}$).

$$\begin{aligned}
P^{1-\sigma} &= \int_{v\in\Omega} (p_v)^{1-\sigma} dv = \Sigma_{V,ch} \int_{v\in\Omega_{V,ch}} (p_v)^{1-\sigma} dv + \Sigma_{V,C\neq ch} \int_{v\in\Omega_{VC}} (p_v)^{1-\sigma} dv \\
&= \Sigma_{V,ch} \left[\int_{v\in\Omega_{V,ch}^{\tilde{z}}} (p_v)^{1-\sigma} dv + \int_{v\in\Omega_{V,ch}\setminus\Omega_{V,ch}^{\tilde{z}}} (p_v)^{1-\sigma} dv\right] + \Sigma_{V,C\neq ch} \int_{v\in\Omega_{VC}} (p_v)^{1-\sigma} dv
\end{aligned}$$

Using the equilibrium price, $p_v = (w_e \tau_V d_V c_v/\rho)$ for the non-upgraders and $z(w_e \tau_V d_V c_v/\rho)$ for the upgraders, as well as the Pareto distribution we obtain ε_V at a state such as the MFN one where the cutoffs

are $c_{mz}^U = \phi c_m^U$ (we omit the state subscript below and the V subscripts for the technological parameters for notational simplicity)

$$\begin{aligned}
\left.\frac{\partial \ln P(\mathbf{c})}{\partial \ln c_V^U}\right|_{\mathbf{c}_C} &= (1-\sigma)^{-1}\frac{c_V^U}{P^{1-\sigma}}\partial\left[\frac{N_V}{c_V^k}\left\{\int_0^{\phi c_V^U}(z w_e \tau_V d_V/\rho)^{1-\sigma} k (c_v)^{k-\sigma} dc + \int_{\phi c_V^U}^{c_V^U}(w_e\tau_V d_V/\rho)^{1-\sigma} k (c_v)^{k-\sigma} dc\right\}\right]/\partial c_V^U \\
&= (1-\sigma)^{-1}\frac{c_V^U}{P^{1-\sigma}}\partial\left[\frac{N_V}{c_V^k}(w_e\tau_V d_V/\rho)^{1-\sigma} k\left\{z^{1-\sigma}\int_0^{\phi c_V^U}(c_v)^{k-\sigma} dc + \int_{\phi c_V^U}^{c_V^U}(c_v)^{k-\sigma} dc\right\}\right]/\partial c_V^U \\
&= (1-\sigma)^{-1}\frac{1}{P^{1-\sigma}}\left[\frac{N_V}{c_V^k}(w_e\tau_V d_V/\rho)^{1-\sigma} k\left\{z^{1-\sigma}\left(\phi c_V^U\right)^{k-\sigma+1} + \left(c_V^U\right)^{k-\sigma+1} - \left(\phi c_V^U\right)^{k-\sigma+1}\right\}\right] \\
&= \left[(1-\sigma)^{-1}\tau_V k \left(d_V w_e/(P\rho)\right)^{1-\sigma}\tau_V^{-\sigma}\frac{N_V}{c_V^k}\left(c_V^U\right)^{k-\sigma+1}\right]\zeta_V
\end{aligned}$$

where $\zeta_V = 1 + (\phi_V)^{1-\sigma+k}\left(z_V^{1-\sigma} - 1\right)$ and the expression in [] is the same we derived for $\varepsilon_V|_{\zeta_V=1}$, i.e. without upgrading so $\varepsilon_V = \varepsilon_V|_{\zeta_V=1}\zeta_V$. This implies that the price elasticity wrt each cutoff is higher under upgrading. Since we also have that exports with upgrading can be written similarly: $R_V = R_V|_{\zeta_V=1}\zeta_V$ we obtain the same general expression for the elasticity when writen in terms of the export value

$$\varepsilon_V \equiv \partial \ln P(\mathbf{c})/\partial \ln c_V^U|_{\mathbf{c}_C} = -\frac{k-\sigma+1}{\sigma-1}\frac{\tau_V R_V}{E}$$

Semi-elasticity of P wrt γ under upgrading

P depends on γ only via c^U so $d\ln P/d\gamma$ is the same as derived without upgrading but now ε_V reflects any upgrading that took place, as embodied in R_V, that is we still obtain

$$\left.\frac{d\ln P_m(\mathbf{c}_m)}{d\gamma}\right|_{\gamma=0} = \frac{\beta p}{(\sigma-1)(1-\beta t_{22})}\frac{(k-\sigma+1)I_m}{(k-\sigma+1)I_m+\sigma-1}\Sigma_V r_{Vm}(1-\tilde{\omega}_{Vm})$$

where $I_m \equiv \frac{\Sigma_V \tau_{Vm} R_{Vm}}{E}$ and the tariff inclusive import weights evaluated under the MFN state are defined as $r_{Vm} \equiv \frac{\tau_{Vm}R_{Vm}}{\Sigma_V \tau_{Vm}R_{Vm}}$

Semi-elasticity of entry and upgrading wrt γ

We also obtain a similar expression in terms of export revenues as in the absence of upgrading for the weighted semi-elasticity of entry with respect to uncertainty

$$\Sigma_V r_{Vm}\left.\frac{d\ln c_{mV}^U}{d\gamma}\right|_{\gamma=0} = \left(1 - \frac{(k-\sigma+1)I_m}{(k-\sigma+1)I_m+\sigma-1}\right)\frac{\beta p}{(\sigma-1)(1-\beta t_{22})}\Sigma_V r_{Vm}(\tilde{\omega}_V - 1)$$

which also applies to the upgrading cutoff since $c_{mz}^U = \phi c_m^U$.

A.5.4 Effect of policy uncertainty on consumer welfare

Workers have direct utility $Q^\mu q_0^{1-\mu}$ where Q is the CES aggregator over all varieties and $\mu \in (0,1]$. Therefore, since q_0 is the numeraire, the period indirect utility when $s = m$ is $\tilde{\mu}P_m^{-\mu}$ where $\tilde{\mu} = w_e k \mu^\mu (1-\mu)^{(1-\mu)}$ is constant since k is the period labor endowment and the wage of the exporter $w_e = 1$ in the diversified equilibrium. Using $t_{m2} = \gamma p$ and $t_{m0} = \gamma(1-p)$ we write the expected welfare for a worker starting at $s = m$ as

$$\begin{aligned}
W_m &= \tilde{\mu}P_m^{-\mu} + \tilde{\beta}\left[\gamma(1-p)W_0 + \gamma p W_{2m} + (1-\gamma)W_m\right] \\
&= \frac{\tilde{\mu}P_m^{-\mu}}{1-\tilde{\beta}(1-\gamma)} + \frac{\tilde{\beta}\gamma}{1-\tilde{\beta}(1-\gamma)}\left[(1-p)W_0 + pW_{2m}\right]
\end{aligned}$$

where W_0 and W_{2m} are the expected welfare values after switching to $s = 0, 2$ respectively.

We obtain the growth in welfare due to a change in γ around $\gamma = 0$ in eq.(36) as follows

$$\begin{aligned}
\left.\frac{d\ln W_m}{d\gamma}\right|_{\gamma=0} &= \left(\frac{1}{W_m}\tilde{\mu}\frac{-\mu P_m^{-\mu-1}\frac{dP_m}{d\gamma}\left(1-\tilde{\beta}\right)-P_m^{-\mu}\tilde{\beta}}{\left(1-\tilde{\beta}\right)^2}+\frac{1}{W_m}\frac{\tilde{\beta}}{1-\tilde{\beta}}\left[(1-p)W_0+pW_{2m}\right]\right)|_{\gamma=0} \\
&= \left(\frac{\tilde{\mu}\left(P_m^D\right)^{-\mu}}{1-\tilde{\beta}}\right)^{-1}\left(\tilde{\mu}\frac{-\mu\left(P_m^D\right)^{-\mu-1}\frac{dP_m}{d\gamma}|_{\gamma=0}\left(1-\tilde{\beta}\right)-\left(P_m^D\right)^{-\mu}\tilde{\beta}}{\left(1-\tilde{\beta}\right)^2}+\frac{\tilde{\beta}}{1-\tilde{\beta}}\left[(1-p)W_0+pW_{2m}\right]|_{\gamma=0}\right) \\
&= -\mu\frac{d\ln P_m}{d\gamma}|_{\gamma=0}-\frac{\tilde{\beta}}{1-\tilde{\beta}}\left(\frac{W_m-(1-p)W_0-pW_{2m}}{W_m}\right)|_{\gamma=0}
\end{aligned}$$

where the impact of γ on W_0 and W_2 disappears because it is multiplied by γ so it will be zero around $\gamma = 0$.

Within state welfare effect of policy uncertainty $-\mu\frac{d\ln P_m}{d\gamma}|_{\gamma=0}$: See Appendix section A.5.2.

Mean state switching welfare effect of policy uncertainty

To derive this note that the deterministic expected welfare is $W_s|_{\gamma=0} = \tilde{\mu}\left(P_s^D\right)^{-\mu}/(1-\beta)$ if $s = 0, m$. After T periods of transition from $s = m$ to $s = 2$ we have

$$W_{2t}|_{\gamma=0} = \tilde{\mu}\left(P_{2t}^D\right)^{-\mu}+\tilde{\beta}\left(t_{22}W_{2t+1}+(1-t_{22})W_m|_{\gamma=0}\right) \quad t = \{0, 1, ..., \infty\}$$

It is straightforward to solve this for the first period after transition to obtain $W_{2m} = W_{20}$ as

$$W_{2m}|_{\gamma=0} = \tilde{\mu}\Sigma_{t=0}^{\infty}\left(\tilde{\beta}t_{22}\right)^t\left(P_{2t}^D\right)^{-\mu}+\frac{1-t_{22}}{1-\tilde{\beta}t_{22}}\tilde{\beta}W_m|_{\gamma=0} \tag{57}$$

Using this and the deterministic values for W_s,at $s = 0, m$ we obtain the mean state switching effect in terms of model parameters and relative price indices. Our approach does not allow us to identify p or t_{22} so we are unable to provide an approximation for this term.

$$\begin{aligned}
\frac{\tilde{\beta}}{1-\tilde{\beta}}\left(\frac{W_m-(1-p)W_0-pW_{2m}}{W_m}\right)\Big|_{\gamma=0} &= \frac{\tilde{\beta}}{1-\tilde{\beta}}\left(1-(1-p)\left(\frac{P_0^D}{P_m^D}\right)^{-\mu}-p\frac{W_{2m}}{W_m}|_{\gamma=0}\right) \\
&= \frac{\tilde{\beta}}{1-\tilde{\beta}}\begin{pmatrix} 1-(1-p)\left(\frac{P_0^D}{P_m^D}\right)^{-\mu} \\ -p\left(\left(1-\tilde{\beta}\right)\Sigma_{t=0}^{\infty}\left(\tilde{\beta}t_{22}\right)^t\left(\frac{P_{2t}^D}{P_m^D}\right)^{-\mu}+\frac{1-t_{22}}{1-\tilde{\beta}t_{22}}\tilde{\beta}\right)\end{pmatrix}
\end{aligned}$$

B Data and Estimation Appendix

B.1 Data sources and definitions

Trade Flow and Product Regressions

Change in Ad valorem Tariffs $\Delta\tau_{mV}$ Log change in 1 plus the statutory ad-valorem MFN tariff rate aggregated to the HS6 level between 2005 and 2000. Source: TRAINS via WITS download.

Change in AVE Tariffs $\Delta\tau_{mV}$ Log change in 1 plus the advalorem equivalent (AVE) of the MFN tariff rate at the HS6 level between 2005 and 2000. For specific tariffs, base year unit values from 1996 used for all years to compute the AVE tariff. Source: TRAINS for tariff rates and COMTRADE for unit values, via WITS download.

Column 2 Tariff τ_{2V} Log of the 1 plus the column 2 (Smoot-Hawley) tariff rate at the HS6 level. For specific tariffs, base year unit values from 1996 used for all years to compute the AVE tariff. Source: TRAINS for tariff rates and COMTRADE for unit values, via WITS download.

Pre-WTO Uncertainty Measure of uncertainty from the model $1 - \left(\frac{\tau_{2V}}{\tau_{mV}}\right)^{-\sigma}$ computed using year 2000 column 2 and MFN tariff rates for ad-valorem and AVE tariff rates respectively.

Change in Transport Costs Δd_V Log change in the ratio of trade values inclusive of costs, insurance and freight (CIF) to free on board value (FOB). Source: CIF/FOB ratios constructed at HS6 level using disaggregated data from Center for International Data (http://cid.econ.ucdavis.edu/)

Change in Transport Costs (Imputed) Δd_V For product and import regressions that use zero trade flows in either 2000 or 2005, we do not observe transport costs and must imputed them. This is done by regressing $\ln(CIF/FOB)$ at the HS-10 digit level from 1996-2006 for China, Australia, Indonesia, Japan, S. Korea, and India on a full set of country×year and HS-10×year fixed effects. We then impute *only* the missing data by product for China using the China×year effects for 2000 and 2005 and the 10 digit product effect, taking the HS-6 average by year, and then computing the change.

Change in TTBs Indicators for in-force temporary trade barriers (TTBs) including anti-dumping duties, countervailing duties, special safeguards, and China-specific special safeguards. Data are aggregated up to HS6 level. Source: World Bank Temporary Trade Barriers Database (Bown, 2012)

Change in MFA Indicators for in-force Multi-Fiber Agreement/Agreement on Textiles and Clothing (MFA/ATC) quotas aggregated to the HS6 level and concorded through time. Source: Brambilla et al. (2010) available at http://faculty.som.yale.edu/peterschott/sub_international.htm

Product Regressions (Table 5)

Change in No. of HS-10 Traded Products Change in log count of traded HS10 products within each HS6 industry from 2000 to 2005. Source: disaggregated data from Center for International Data (http://cid.econ.ucdavis.edu/)

Categorical Variable for {Increase, No Change or Decrease} for Ordered Probit Mutually exclusive grouping by HS6 for whether the number of traded HS10 products increased, did not change or decreased from 2000 to 2005. Within each HS6, we also track whether (a) U.S. customs changed the absolute number of tradable HS-10 products it tracks for statistical purposes, and (b) the HS6 industry is "maxed out" in 2000 or 2005 so that it is not possible to observe an increase in traded products. These details are used for sample restriction robustness in Table 6. Source: disaggregated data from Center for International Data (http://cid.econ.ucdavis.edu/)

Concordances

We use the concordances tables available in WITS to map all variables to the 1996 Harmonized System at the 6 digit level (HS-6). The tables are developed by the United Nations Statistics Division (UNSD) based on correlation tables constructed by the World Custom Organization (WCO). The WCO provides a mapping from the new revision to the previous revision every time that a new revision is enacted. For further information about the concordances tables construction see <http://unstats.un.org/unsd/trade/conversions/Correlation and conversion tables used in UN Comtrade - General Note.pdf>

Moreover, we track whether there are changes in the number of 8 digit tariff line headings within concorded HS-6 subheadings and whether the concorded line maps to itself following the revision. This is important to avoid spurious changes in applied tariffs and our uncertainty measure due only to changes in product classification. We thus restrict the baseline sample to stable HS-6 codes that have the same set of 8 digit tariff present from 1996-2005.

B.2 Additional Robustness and Falsification Tests

If the growth rate trend is industry specific, $\Delta(\ln N_V) = \theta_V$, and θ_V is correlated with our policy or trade cost variables, then identification is still possible via a difference-of-differences approach, i.e. double differencing. We address this possibility by double differencing, assuming for identification that the industry trend component of the growth rate is constant over time conditional on controls. We illustrate this using the mass of firms but the variables in a_V could also be allowed to have industry specific time trends. This yields the following long difference

$$\Delta_{m0} \ln R_V = b_\gamma \left(1 - \left(\frac{\tau_{2V}}{\tau_{mV}}\right)^{-\sigma}\right) + b_\tau \Delta \ln \tau_V + b_d \Delta \ln D_V + b + \theta_V + u_V \tag{58}$$

where Δ_{m0} is subscripted to denote the difference over a transition from m to 0.

Now consider taking the difference between two years that remain in state m. For example, if the difference above uses 2000 (m) and 2005 (0) and we will now use the difference between 1999(m) and 1996(m) and denote it by Δ_{mm}

$$\Delta_{mm} \ln R_V = -\Delta_{mm} b'_\gamma \left(1 - \left(\frac{\tau_{2V}}{\tau_{mV}}\right)^{-\sigma}\right) + b_\tau \Delta_{mm} \ln \tau_V + b_d \Delta_{mm} \ln D_V + b' + \theta_V + u'_V. \tag{59}$$

Since both our uncertainty measure and the estimated parameters on the uncertainty measure could change over time, we denote the parameter on uncertainty by b'_γ and note that there are two components to the change in the first term

$$-\Delta_m b'_\gamma \left(1 - \left(\frac{\tau_{2V}}{\tau_{mV}}\right)^{-\sigma}\right) = -b'_m \Delta_{mm} \left(1 - \left(\frac{\tau_{2V}}{\tau_{mV}}\right)^{-\sigma}\right) - \left(1 - \left(\frac{\tau_{2V}}{\tau_{mV}}\right)^{-\sigma}\right) \Delta_{mm} b'_m$$

The second term is evaluated at final period tariffs, which are very close to 2000 levels. Because τ_{2V} is fixed during this period and any variation in $\left(\frac{\tau_{2V}}{\tau_{mV}}\right)$ is due to small changes in τ_{mV}, already controlled by $\Delta_{mm} \ln \tau_V$, we take $\Delta_m \left(1 - \left(\frac{\tau_{2V}}{\tau_{mV}}\right)^{-\sigma}\right) \approx 0$ to obtain

$$\begin{aligned} -\Delta_m b'_\gamma \left(1 - \left(\frac{\tau_{2V}}{\tau_{mV}}\right)^{-\sigma}\right) &\approx -\left(1 - \left(\frac{\tau_{2V}}{\tau_{mV}}\right)^{-\sigma}\right) \Delta_m b'_\gamma \\ &= -\left(1 - \left(\frac{\tau_{2V}}{\tau_{mV}}\right)^{-\sigma}\right) \frac{k - \sigma + 1}{\sigma - 1} \frac{\beta t_{m2}}{1 - \beta} \Delta_m g'_m = -\left(1 - \left(\frac{\tau_{2V}}{\tau_{mV}}\right)^{-\sigma}\right) \frac{b_\gamma}{g_m} \Delta_m g'_m. \end{aligned}$$

We then take the double difference, normalizing each differenced RHS variable by the length of the time period to obtain magnitudes comparable to our first differenced results

$$\frac{\Delta_{m0}\ln R_V}{5} - \frac{\Delta_{mm}\ln R_V}{3} = b_\gamma\left(1+\frac{\Delta_m g'_m}{g_m}\right)\frac{\left(1-\left(\frac{\tau_{2V}}{\tau_{mV}}\right)^{-\sigma}\right)}{5} + b_\tau\left(\frac{\Delta_{m0}\ln\tau_V}{5} - \frac{\Delta_{mm}\ln\tau_V}{3}\right) \quad (60)$$
$$+ b_d\left(\frac{\Delta_{m0}\ln D_V}{5} - \frac{\Delta_{mm}\ln D_V}{3}\right) + b - b' + u_V - u'_V$$

The coefficients from estimating the double difference equation (60) have the same interpretation as our baseline long difference regression. We note that the sample size drops considerably to 2,285 since we can only use HS6 industries that were traded in 2005, 2000, 1999, and 1996 in order for the double differenced log change to exist. Further, the double differenced variables are somewhat noisy, as the standard deviations in Table A1 indicate. We handle this by running a robust regression routine that downweights outliers more than 7 times the median absolute deviation from the median residuals, iterating until convergence. Consistent with the baseline results, we find a significant and positive effect of uncertainty on import growth, even when we include changes in the MFA and TTBs.

We also run a falsification test using only the pre-accession growth rates from equation (59). We want to show there was no change in uncertainty in this prior period and that there were no anticipation effects of expected future entry. The sub-period from 1996-1999 is informative as it was time when China continued to face the MFN renewal process and it's admission to the WTO had not been secured. Importantly though, the WTO had been created and any new commitments the U.S. agreed in the Uruguay Round for all WTO members were in place or being phased-in (i.e. the reduction in quotas under the MFA). In columns 3-4 we run robust regression estimations using the 1996 level of uncertainty for China. We find that the coefficients on tariffs and transports costs are relatively stable, but the uncertainty measure is insignificant and nearly zero.

Table 1: Summary statistics by pre-WTO policy uncertainty

	Uncertainty		
	Low	**High**	**Total**
Import Growth (ln), 2005-2000*	1.145	1.328	1.265
	[1.775]	[1.533]	[1.623]
Change in MFN tariff (ln)	-0.002	-0.004	-0.003
	[0.007]	[0.010]	[0.009]
Change in transport costs (ln)	-0.01	-0.003	-0.005
	[0.101]	[0.077]	[0.086]
MFN tariff (ln), 2000	0.03	0.046	0.04
	[0.037]	[0.051]	[0.047]
Column 2 tariff (ln), 2000	0.16	0.395	0.314
	[0.096]	[0.121]	[0.159]
Potential profit loss in worst case (pre WTO)	0.304	0.637	0.522
	[0.174]	[0.086]	[0.201]
Observations			2829

Notes:

Means with standard deviations in brackets.

Baseline regression sample from Table 1.

* Difference of means between High and Low import growth signficant at 1% level

Low and High refer to the bottom and top tercile of each variable. Total includes the full sample.

Table 2: Chinese import growth (2005-2000), baseline specification

	1	2	3	4
Dependent variable (ln):	Import growth (2005-2000)			
Uncertainty Pre-WTO	0.702***	0.739***	0.597***	0.614***
	[0.165]	[0.161]	[0.200]	[0.198]
Change in Tariff (ln)	-8.796*	-4.481***	-7.407	-4.421***
	[4.767]	[0.712]	[5.439]	[0.710]
Change in Transport Costs (ln)	-2.921***	-2.987***	-2.911***	-2.947***
	[0.478]	[0.474]	[0.477]	[0.474]
constant	0.854***	0.848***		
	[0.0925]	[0.0920]		
Observations	2,829	2,829	2,829	2,829
R-squared	0.034	.	0.054	.
Section FE	no	no	yes	yes
Constrained	no	yes	no	yes
Restriction p-value (F-test)	0.359	1	0.579	1

Notes:

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.10

Sample: U.S. import value at HS6 level in logs for 6 digit HS codes that are stable over time with ad-valorem tariffs.

Uncertainty measures are the mean within each HS6 sub-heading using U.S. MFN tariff and Column 2 Tariff evaluated at sigma=3

Restriction: tariff/transport cost=sigma/(sigma-1)

Table 3: Robustness to other policy barriers

	1	2	3	4	5
Dependent variable (ln):	Import growth (2005-2000)				
Specification:	Baseline	+MFA/TTB	+Section FE	IV (TTB)	Constrained
Panel A: Ad-valorem tariff (statutory)					
Uncertainty Pre-WTO	0.702***	0.652***	0.610***	0.614***	0.633***
	[0.165]	[0.162]	[0.199]	[0.199]	[0.197]
Change in Tariff (ln)	-8.796*	-8.277*	-8.463	-8.558	-4.488***
	[4.767]	[4.871]	[5.403]	[5.436]	[0.706]
Change in Transport cost (ln)	-2.921***	-2.926***	-2.944***	-2.948***	-2.992***
	[0.478]	[0.475]	[0.473]	[0.471]	[0.471]
Change in MFA quota status		-0.143	-0.321**	-0.321**	-0.313**
		[0.101]	[0.131]	[0.130]	[0.129]
Change in TTB status		-1.016***	-1.029***	-1.203	-1.021***
		[0.350]	[0.361]	[1.238]	[0.361]
Observations	2,829	2,829	2,829	2,829	2,829
R-squared	0.034	0.041	0.062	0.062	
Section FE	no	no	yes	yes	yes
F-stat, 1st Stage				6.327	
Over-ID restriction (p-value)				0.298	
Restriction p-value (F-test)	0.359	0.429	0.457	0.449	
Panel B: Ad-valorem equivalent (AVE)					
Uncertainty Pre-WTO	0.879***	0.830***	0.725***	0.770***	0.668***
	[0.139]	[0.138]	[0.165]	[0.174]	[0.162]
Change in Tariff (ln)	-1.598	-0.907	-1.241	-1.083	-3.970***
	[1.629]	[1.657]	[1.740]	[1.784]	[0.609]
Change in Transport cost (ln)	-2.844***	-2.849***	-2.855***	-2.898***	-2.647***
	[0.437]	[0.434]	[0.435]	[0.436]	[0.406]
Change in MFA quota status		-0.187*	-0.292**	-0.292**	-0.271**
		[0.0962]	[0.128]	[0.127]	[0.128]
Change in TTB status		-1.108***	-1.123***	-3.538	-1.118***
		[0.344]	[0.354]	[2.556]	[0.354]
Observations	3,145	3,145	3,145	3,145	3,145
R-squared	0.037	0.046	0.07	0.037	
Section FE	no	no	yes	yes	yes
F-stat, 1st Stage				3.961	
Over-ID restriction (p-value)				0.203	
Restriction p-value (F-test)	0.131	0.0604	0.104	0.0889	

Notes:

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.10

Excluded instruments for Change in TTB are TTB indicators for 1998 and 1997.

Sample: U.S. import value at HS6 level in logs for 6 digit HS codes that are stable over time.

Uncertainty measures are the mean within each HS6 sub-heading using U.S. MFN tariff and Column 2 Tariff evaluated at sigma=3

Restriction: tariff/transport cost=sigma/(sigma-1)

Table 4: Contribution of Uncertainty to Import Growth (2000-2005)

	Upper bound	Partial	GE
Average import growth from lower uncertainty (Δln)	0.32	0.30	0.28
Share of import growth predicted by uncertainty reduction*	0.33	0.30	0.28
Ad Valorem transport cost equivalent of uncertainty (Δln)	0.11	0.10	0.10
Ad Valorem tariff equivalent of uncertainty (Δln)	0.073	0.067	0.066

Notes:
Quantification uses estimates with section fixed effects and constraint on transport costs and tariffs from column 4 of Table 2. See the text for calculation details.

*(Arithmetic growth rate predicted by uncertainty removal)/(Observed growth rate)

Table 5: Chinese product entry growth (2005-2000)

	1	2	3	4	5
Dependent variable (ln):	Change in No. of HS-10 traded (OLS)			Probability of increase, decrease, no change in HS-10	
Estimation:	OLS			Ordered Probit	
Uncertainty Pre-WTO	0.193**	0.166*	0.177*	0.758***	0.627***
	[0.0756]	[0.0940]	[0.0934]	[0.265]	[0.198]
Change in Tariff (ln)	-2.325*	-1.794	-0.786***	-0.244	2.192
	[1.328]	[1.367]	[0.252]	[3.912]	[3.253]
Change in Transport cost (ln)[a]	-0.527***	-0.507***	-0.524***	-0.383	-0.219
	[0.173]	[0.170]	[0.168]	[0.454]	[0.338]
Observations	1,057	1,057	1,057	1,057	1,510
R-squared	0.022	0.06	.		
PR2	.	.	.	0.056	0.042
Section FE	no	yes	yes	yes	yes
Tariff and Transp. constraint	no	no	yes	no	no
Changes to/from zero trade	no	no	no	no	yes

Notes:

Robust standard errors in brackets, *** p<0.01, ** p<0.05, * p<0.1

All regressions drop max-to-max transitions - observations at the maximum at beginning and end of period - and zero-to-zero transitions that are non-traded throughout the sample period. Section fixed effects included in all specifications. Ordered probit estimated over 3 states for change in number of traded products {decrease, no change, increase}. Unreported cutpoints of the ordered probit are statistically different at the 5% level.

a: in regressions that include transitions to/frome zero, trade costs are imputed in the unobserved year before computing the change.

Table 6: Contribution of Uncertainty to Firm Entry (2000-2005)

	Upper bound	Partial	GE
Average entry from lower uncertainty (Δln)	0.52	0.48	0.46
Average entry predicted by uncertainty reduction/total observed entry	0.63	0.58	0.56
Ad Valorem transport cost equivalent of uncertainty (Δln)	0.18	0.164	0.167
Ad Valorem tariff equivalent of uncertainty (Δln)	0.12	0.11	0.11

Notes:
Quantification uses estimates with section fixed effects and constraint on transport costs and tariffs from column 3 of Table 5
See the text for calculation details

Table A1: Summary Statistics Across Regression Specifications

Table:	1-3A, A3-4	3B	A5	A5	A6*	A6
Columns:	All	All	Panel A	Panel B	1-2	3-4
Import Growth (ln)	1.265	1.224	1.291	1.245	-0.00825	0.715
	[1.623]	[1.635]	[1.673]	[1.679]	[0.571]	[1.431]
Uncertainty Pre-WTO (2000)	0.522	0.519	0.52	0.518	0.107	0.52
	[0.201]	[0.225]	[0.202]	[0.226]	[0.0385]	[0.191]
Change in Tariff (ln)	-0.00318	-0.00608	-0.00313	-0.00638	0.00273	-0.0102
	[0.00877]	[0.0206]	[0.00883]	[0.0213]	[0.00402]	[0.0134]
Change in MFA quota status (binary)	-0.134	-0.123	-0.129	-0.119	-0.00272	0.0071
	[0.341]	[0.329]	[0.335]	[0.324]	[0.0279]	[0.0720]
Change in TTB status (binary)	0.00813	0.00763	0.00801	0.0075	0.000904	-0.0189
	[0.126]	[0.126]	[0.124]	[0.123]	[0.0388]	[0.136]
Change in Transport Costs (ln)	-0.00548	-0.00565	-0.00504	-0.00549	-0.016	0.00307
	[0.0862]	[0.0870]	[0.0870]	[0.0881]	[0.0793]	[0.0695]
Observations	2,829	3,145	3,244	3,601	2,285	2,277

Notes:
See referenced table and text for detailed information about sample and variable definitions. *All change variables for Table A6, columns 1-2 are the difference of annualized log changes between post- and pre-WTO sub periods that are 5 and 3 years in length.

Table A2: Chinese import growth (2005-2000), full sample baseline specification

	1	2	3	4
Dependent variable (ln):	Import growth (2005-2000)			
Uncertainty Pre-WTO	0.661***	0.711***	0.646***	0.663***
	[0.158]	[0.154]	[0.188]	[0.186]
Change in Tariff (ln)	-9.866**	-3.984***	-6.72	-3.905***
	[4.474]	[0.702]	[5.058]	[0.704]
Change in Transport Costs (ln)	-2.563***	-2.656***	-2.568***	-2.603***
	[0.474]	[0.468]	[0.474]	[0.469]
constant	0.903***	0.895***		
	[0.0882]	[0.0878]		
Observations	3,244	3,244	3244	3,244
R-squared	0.027		0.048	
Section FE	no	no	yes	yes
Restriction p-value (F-test)	0.184	.	0.575	.

Notes:

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.10

Sample: U.S. import value at HS6 level in logs for 6 digit HS codes with ad-valorem tariffs.

Uncertainty measures are the mean within each HS6 sub-heading using U.S. MFN tariff and Column 2 Tariff evaluated at

Restriction: tariff/transport cost=sigma/(sigma-1)

Table A3: Chinese Import Growth (2005-2000) -- robustness across elasticity of subsititution

	1	2	3	4	5	6
Dependent variable (ln):	Import growth (2005-2000)					
Panel A: Baseline Specification and Sample						
	Unconstrained			Constrained		
Sigma =	2	3	4	2	3	4
Uncertainty Pre-WTO	0.799***	0.702***	0.669***	0.831***	0.739***	0.704***
	[0.201]	[0.165]	[0.148]	[0.196]	[0.161]	[0.145]
Change in Tariff (ln)	-8.875*	-8.796*	-8.772*	-5.948***	-4.481***	-3.989***
	[4.779]	[4.767]	[4.756]	[0.943]	[0.712]	[0.633]
Change in Transport Costs (ln)	-2.915***	-2.921***	-2.927***	-2.974***	-2.987***	-2.992***
	[0.479]	[0.478]	[0.478]	[0.472]	[0.474]	[0.475]
constant	0.901***	0.854***	0.811***	0.897***	0.848***	0.805***
	[0.0871]	[0.0925]	[0.0973]	[0.0867]	[0.0920]	[0.0968]
Observations	2,829	2,829	2,829	2,829	2,829	2,829
R-squared	0.033	0.034	0.035			
Restriction p-value (F-test)	0.531	0.359	0.309			
Panel B: Baseline Sample with Sector effects						
	Unconstrained			Constrained		
Sigma =	2	3	4	2	3	4
Uncertainty Pre-WTO	0.669***	0.597***	0.572***	0.680***	0.614***	0.590***
	[0.242]	[0.200]	[0.181]	[0.239]	[0.198]	[0.180]
Change in Tariff (ln)	-7.534	-7.407	-7.313	-5.866***	-4.421***	-3.935***
	[5.440]	[5.439]	[5.438]	[0.942]	[0.710]	[0.632]
Change in Transport Costs (ln)	-2.906***	-2.911***	-2.915***	-2.933***	-2.947***	-2.951***
	[0.477]	[0.477]	[0.476]	[0.471]	[0.474]	[0.474]
Observations	2,829	2,829	2,829	2,829	2,829	2,829
R-squared	0.053	0.054	0.054			
Restriction p-value (F-test)	0.755	0.579	0.531			

Notes:

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.10

Section level fixed effects in all regressions in panel b

Sample: U.S. import value at HS6 level in logs for 6 digit HS codes that are stable over time with ad-valorem tariffs.

Uncertainty measures are the mean within each HS6 sub-heading using U.S. MFN tariff and Column 2 Tariff

Restriction: tariff/transport cost=sigma/(sigma-1)

Table A4: Robust regression on growth in imports from China (2000-2005)

	1	2	3	4
Dependent variable (ln):	Growth rate of imports (ln)			
	Unconstrained		Constrained	
Uncertainty Pre-WTO	0.442***	0.450***	0.464***	0.475***
	[0.154]	[0.154]	[0.153]	[0.153]
Change in Tariff (ln)	-8.407***	-9.243***	-4.422***	-4.433***
	[3.238]	[3.242]	[0.438]	[0.438]
Change in Transport cost (ln)	-2.887***	-2.878***	-2.948***	-2.955***
	[0.294]	[0.294]	[0.292]	[0.292]
Change in MFA quota status		-0.227*		-0.216*
		[0.117]		[0.117]
Change in TTB status		-0.368*		-0.356*
		[0.204]		[0.204]
Observations	2,829	2,829	2,829	2,829
Section FE	yes	yes	yes	yes
R-squared	0.066	0.068	0.066	0.068

Notes:

Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.10

Robust regression downweights outliers more than 7 times the median absolute deviation from the median residual. It iterates first over Huber weights until convergence and then and Bi-weights.

Restriction: tariff/transport cost=sigma/(sigma-1)

Constrained regressions impose constraint on the data prior to robust regression estimation.

Section level fixed effects in all regressions

Sample: U.S. import value at HS6 level in logs for 6 digit HS codes that are stable over time with ad-valorem tariffs.
Uncertainty measures are the mean within each HS6 sub-heading using U.S. MFN tariff and Column 2 Tariff using sigma=3

Table A5: Robustness to concordance & other policy barriers

	1	2	3	4	5
Dependent variable (ln):	Import growth (2005-2000)				
Specification:	Baseline	+MFA/TTB	+Section FE	IV (TTB)	Constrained
Panel A: Ad-valorem tariff (statutory)					
Sigma =	3	3	3	3	3
Uncertainty Pre-WTO	0.661***	0.602***	0.646***	0.652***	0.668***
	[0.158]	[0.156]	[0.187]	[0.187]	[0.186]
Change in Tariff (ln)	-9.866**	-8.916*	-7.584	-7.724	-3.958***
	[4.474]	[4.547]	[5.058]	[5.047]	[0.700]
Change in Transport cost (ln)	-2.563***	-2.555***	-2.594***	-2.601***	-2.639***
	[0.474]	[0.470]	[0.471]	[0.469]	[0.467]
Change in MFA quota status		-0.176*	-0.313**	-0.313**	-0.304**
		[0.100]	[0.136]	[0.136]	[0.135]
Change in TTB status		-0.830**	-0.908***	-1.297	-0.903***
		[0.332]	[0.339]	[0.900]	[0.339]
Observations	3,244	3,244	3,244	3,244	3,244
R-squared	0.027	0.032	0.053	0.053	
Section FE	no	no	yes	yes	yes
F-stat, 1st Stage				10.2	
Over-ID restriction (p-value)				0.58	
Restriction p-value (F-test)	0.184	0.27	0.47	0.453	
Panel B: Ad-valorem equivalent (AVE)					
Uncertainty Pre-WTO	0.886***	0.824***	0.819***	0.863***	0.747***
	[0.132]	[0.132]	[0.152]	[0.159]	[0.149]
Change in Tariff (ln)	-0.892	-0.167	-0.245	-0.0715	-3.404***
	[1.431]	[1.442]	[1.536]	[1.570]	[0.599]
Change in Transport cost (ln)	-2.497***	-2.489***	-2.516***	-2.554***	-2.269***
	[0.431]	[0.427]	[0.431]	[0.431]	[0.400]
Change in MFA quota status		-0.241**	-0.296**	-0.296**	-0.276**
		[0.0961]	[0.133]	[0.132]	[0.133]
Change in TTB status		-0.930***	-1.015***	-3.454	-1.007***
		[0.329]	[0.335]	[2.235]	[0.335]
Observations	3,601	3,601	3,601	3,601	3,601
R-squared	0.031	0.037	0.062	0.031	
Section FE	no	no	yes	yes	yes
F-stat, 1st Stage				5.8	
Over-ID restriction (p-value)				0.335	
Restriction p-value (F-test)	0.0723	0.0257	0.0364	0.0291	

Notes:

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.10

Excluded instruments for Change in TTB are TTB indicators for 1998 and 1997.

Sample: U.S. import value at HS6 level in logs for all 6 digit HS codes with positive imports in 2000 and 2005

Uncertainty measures are the mean within each HS6 sub-heading using U.S. MFN tariff and Column 2 Tariff and sigma=3

Restriction: tariff/transport cost=sigma/(sigma-1)

Table A6: Robustness to Industry Level (HS6) and Pre-Accession Trends

	1	2	3	4
Dependent variable (ln):	Annualized Difference in Import Growth (2005-2000)/5-(1999-1996)/3		Pre-Accession Import Growth (1999-1996)	
Uncertainty Pre-WTO (2000)	0.567**	0.496**		
	[0.236]	[0.237]		
Uncertainty Pre-WTO (1996)			0.0175	0.0574
			[0.116]	[0.117]
Change in Tariff (ln)	-8.201***	-7.689***	-4.936***	-4.714***
	[2.255]	[2.265]	[1.653]	[1.645]
Change in Transport Cost (ln)	-3.193***	-3.229***	-3.395***	-3.382***
	[0.317]	[0.315]	[0.305]	[0.303]
Change in MFA quota status		-0.323***		0.499***
		[0.113]		[0.161]
Change in TTB status		-0.304		-0.423
		[0.227]		[0.315]
Observations	2,285	2,285	2,277	2,277
R-squared	0.048	0.054	0.056	0.06

Notes:

Standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.10.

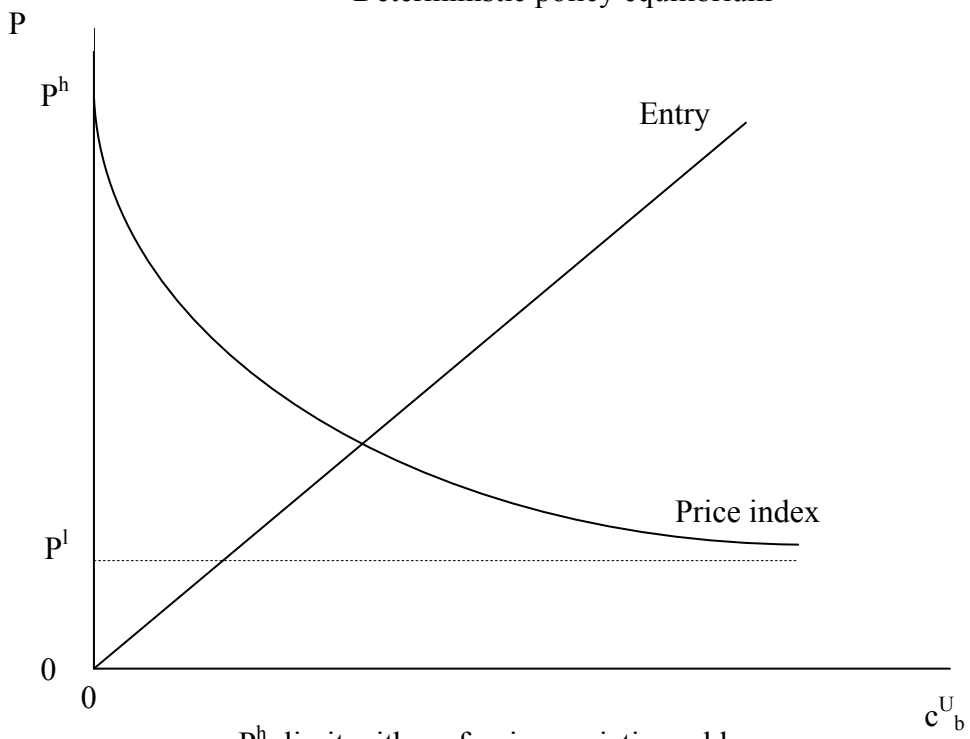
Robust regression employed to address potential effect of outliers or influential individual observations due to double differencing. The rreg estimation downweights outliers more than 7 times the median absolute deviation from the median residual. It iterates first over Huber weights until convergence and then and Bi-weights. The comparable single differencing version using rreg is in column 1 of Table A3 and generates similar coefficients.

Sample: U.S. import value at HS6 level in logs for 6 digit HS codes that are stable over time.

Uncertainty measures are the mean within each HS6 sub-heading using U.S. MFN tariff and Column 2 Tariff

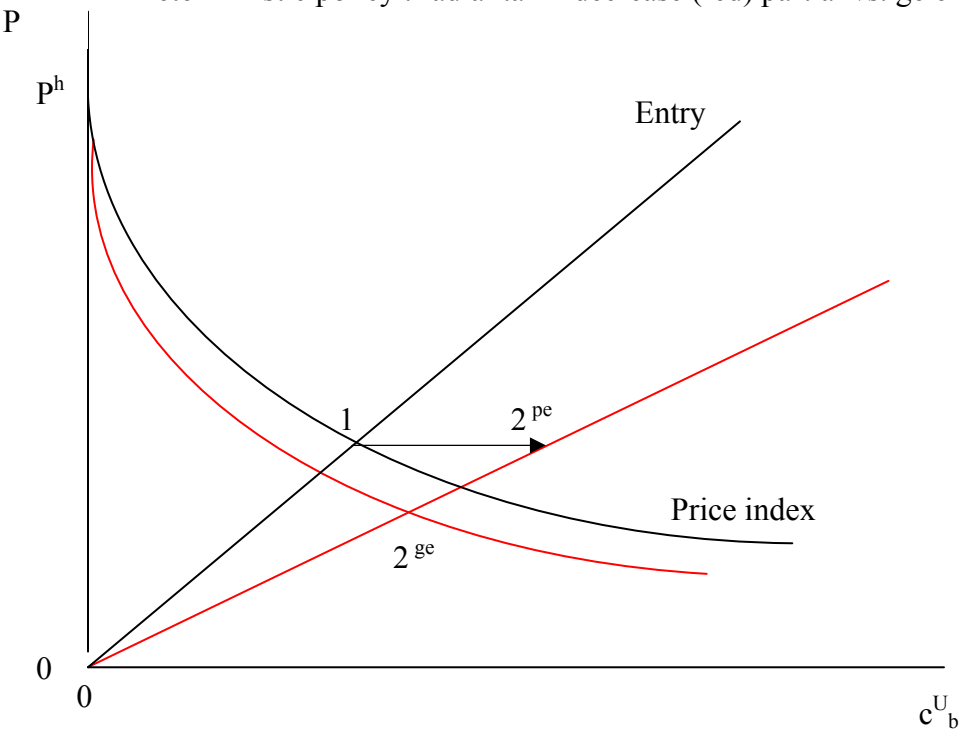
Restriction: tariff/transport cost=sigma/(sigma-1)

Figure 1
Deterministic policy equilibrium



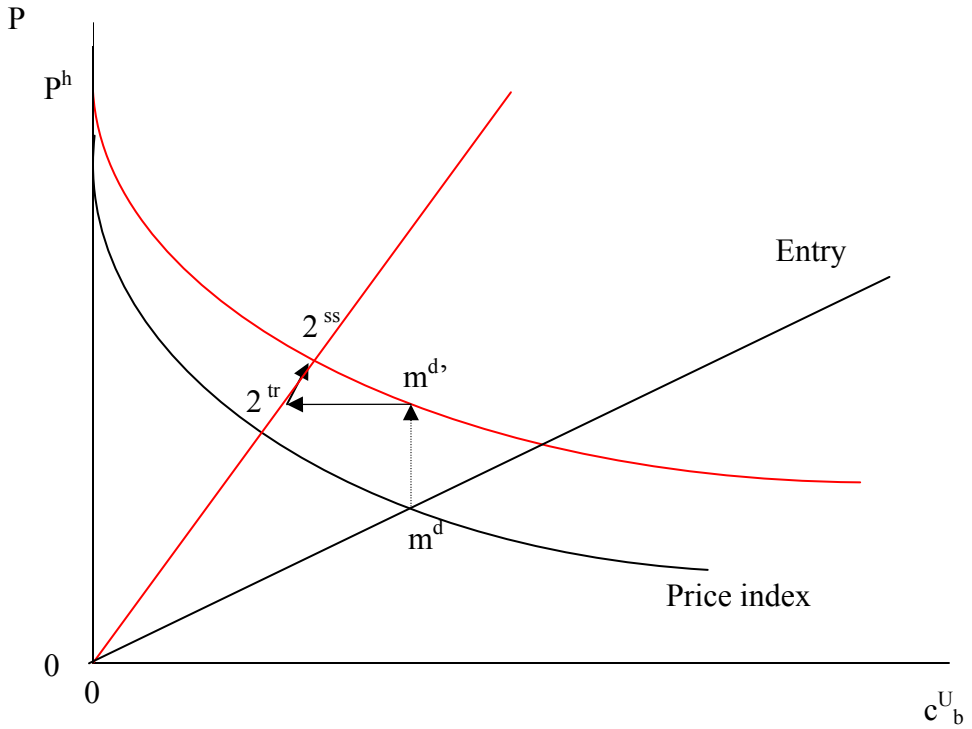
P^h: limit with no foreign varieties sold
P^l limit with all foreign varieties sold

Figure 2
Deterministic policy : radial tariff decrease (red) partial vs. ge effect on entry



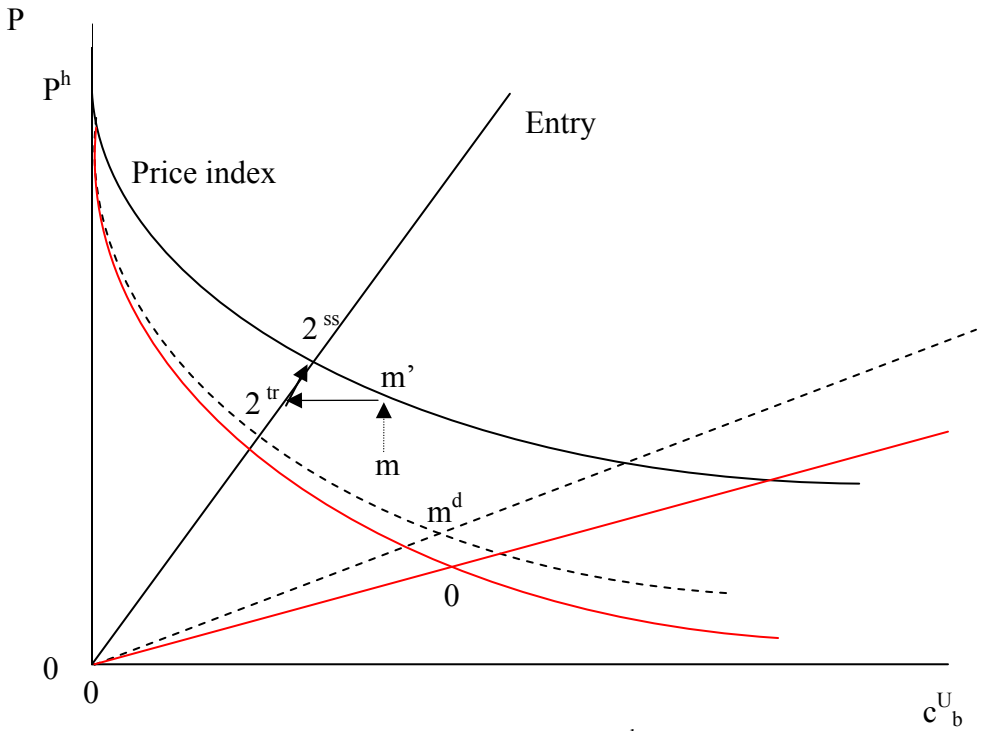
1: Initial equilibrium, 2^{pe}: Equilibrium after tariff reduction in partial equilibrium
2^{ge}: equilibrium under ge. Radial decrease: $d\ln(\tau_V)=\delta<0$ for all V.

Figure 3
Transition dynamics after unexpected (radial) tariff increase (red)



1: Initial deterministic equilibrium (mfn), 1': Lower bound price index after shock (IF no death), 2^{tr} lower bound cutoff after shock), 2^{ss} : Steady state under column 2.

Figure 4
Comparison of equilibria under policy uncertainty: Column 2, MFN, WTO



m: MFN equilibrium with uncertainty, m^d Equilibrium under mfn without uncertainty w: equilibrium after WTO under no uncertainty (if tariffs reduced); $2^{tr} \rightarrow 2^{ss}$ transition path after switch to column 2 state under uncertainty until new shock leading to m occurs.