Uncertainty and Trade Agreements*

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Abstract

In this paper we explore the potential gains that a trade agreement (TA) can provide by regulating trade-policy uncertainty, in addition to the more standard gains from reducing the mean levels of trade barriers. We show that in a standard trade model with income-risk neutrality there tends to be an uncertainty-increasing motive for a TA. With income-risk aversion, on the other hand, the uncertainty-managing motive for a TA is determined by interesting trade-offs. For a given degree of risk aversion, an uncertainty-reducing motive for a TA is more likely to be present when the economy is more open, the export supply elasticity is lower and the economy is more specialized. Governments have stronger incentives to sign a TA when the trading environment is more uncertain. As exogenous trade costs decline, the gains from decreasing trade-policy uncertainty tend to grow, both in absolute terms and relative to the gains from reducing average trade barriers. We also derive a simple “sufficient statistic” to determine whether there is an uncertainty-reducing motive for a TA: this is the case if, at the noncooperative equilibrium, an adjusted measure of the exporting country’s openness co-vars with the importing country’s tariff as a result of the shocks. Finally, we investigate the impact of a TA on investment and trade via changes in trade-policy uncertainty.

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1. Introduction

Policy practitioners often argue that a central benefit of trade agreements is to reduce trade policy uncertainty. Indeed, the WTO and other trade agreements (TAs) explicitly state that one of their goals is to increase the predictability of the trade policy environment.\footnote{For example, the WTO’s web site 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.” As another example, the 2001 Mexico-EU Free Trade Area states that its goals are “to create an expanded and secure market for goods and services” and “to ensure a stable and predictable environment for investment.”} The recent great recession illustrates the potential value of such agreements in reducing trade policy uncertainty. During that crisis there was widespread fear of disastrous trade wars, such as those in the 1930’s that preceded (and spurred) the creation of the GATT. But while applied protection increased, the worst fears were not realized (cf. Bown, 2011). It is at least conceivable that one of the reasons why trade wars did not happen is that countries are constrained by TAs that limit policy variation even under large shocks.

In spite of the importance that policy makers and international institutions attribute to the notion of an uncertainty-reducing role of TAs, we know little about its theoretical underpinnings. A large body of theory has explored the possible roles of a TA as a means to correct international policy externalities (e.g. Grossman and Helpman [1995], Bagwell and Staiger [1999] and Ossa [2011]) and to allow governments to commit vis-a-vis domestic actors (e.g. Maggi and Rodriguez-Clare [1998] and Limão and Tovar-Rodriguez [2011]). But this research focuses on the role of a TA in managing the level of trade barriers, not their uncertainty.

The main objective of our paper is to explore the conditions under which there is a policy-uncertainty-reducing motive for a TA, and examine the potential gains that a TA can provide by regulating trade-policy uncertainty, above and beyond the more standard gains from reducing the levels of trade barriers. A further aim of our paper is to investigate the impact of a TA on investment and trade via changes in trade-policy uncertainty.

We focus on a scenario where there are no frictions in contracting between governments, so that the TA is a complete contingent contract. Since we are focusing on the motives and potential gains from a TA, rather than on the design of TAs, it seems natural to focus on a setting without transaction costs.\footnote{Also, if a TA reduces policy uncertainty solely because it is too costly to include contingencies in the contract, then it is hard to argue that the motive of the TA is to reduce policy uncertainty; rather, the reduction in uncertainty in this case would be a mechanical side effect of the contracting frictions.}
To isolate the uncertainty-managing motive for a TA we perform the following thought experiment: we focus on the optimal “mean preserving agreement” (MPA), i.e. the optimal agreement among those that keep the average trade barriers at the noncooperative level. If the optimal MPA leads to a policy distribution that is different from the noncooperative one, we say that there is an “uncertainty-managing motive” (or simply an “uncertainty motive”) for a TA, and if the optimal MPA reduces policy uncertainty relative to the noncooperative equilibrium we say that there is an “uncertainty-reducing motive” for the TA.

We start with a simple framework in which we specify reduced-form government objectives as functions of a trade policy and an underlying shock. Initially we focus on a setting where only the importing country (Home) chooses a trade policy, $t$, and this policy exerts an international externality on the exporting country (Foreign). Home’s noncooperative choice of $t$ is increasing in some shock, $\lambda$, and both $t$ and $\lambda$ can potentially affect Foreign’s objective. This setting can be interpreted as one where Foreign is a small welfare-maximizing country that practices free trade.

We identify two key effects in determining whether there is an uncertainty motive for a TA. The first one is what we label policy-risk preference effect, determined by the concavity/convexity of Foreign’s objective with respect to Home’s policy: when Foreign is policy-risk averse, this effect works in favor of an uncertainty-reducing motive. Intuition might suggest that this effect is all that matters for determining whether there is “too much” or “too little” risk in the noncooperative policy. And indeed this is the case when shocks affect Foreign only through the policy (“political economy” shocks). However, when the shocks affect Foreign directly, and not just via the policy (“economic” shocks), there is an additional effect that we label externality-shifting effect. This effect is given by the direct impact of the shock on the marginal externality imposed by the policy on Foreign: if an increase in $\lambda$ strengthens this externality (for a given policy level), then this effect works in favor of the uncertainty-reducing

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3We also consider an alternative thought experiment, which focuses on the tariff schedule that a government would unilaterally choose if it were constrained to deliver the same mean as the optimal agreement. If such “mean-preserving unilateral” choice exhibits more uncertainty than the optimal TA, we say that there is an uncertainty-reducing motive. In section 2 we will discuss the similarities and differences between the results under the two thought experiments, and the reasons we choose the MPA thought experiment as the base for our analysis.

4While the main focus of our paper is on TAs, we notice that our basic framework with reduced-form government objectives can be applied also to other types of international agreements, such as environmental agreements or investment agreements.

5In this paper we use the words “risk” and “uncertainty” interchangeably.
motive. Interestingly, therefore, in this case the uncertainty motive for a TA can go in the opposite direction as that of Foreign’s policy-risk preference.

Our next step is to examine the uncertainty motive for a TA and the gains from regulating trade-policy uncertainty in the context of a standard trade model, and in particular, a competitive general-equilibrium trade model with two goods. In our basic model we consider shocks of the political-economy type; we later extend the model to allow for more general shocks.

It is natural to start by focusing on the benchmark case of income-risk neutral individuals. In this case we find that there tends to be an uncertainty-\textit{increasing} motive for a TA. The reason for this result is that, with political-economy shocks, all that matters for the uncertainty motive is Foreign’s policy-risk preference (as mentioned above), and in the presence of income-risk neutrality Foreign tends to be policy-risk \textit{loving}.\textsuperscript{6} We regard this as an interesting “puzzle” arising from the standard trade model with income-risk neutrality: this model seems at odds with the often-heard informal argument that TAs can provide gains by reducing trade-policy uncertainty.

We then focus on the case of income-risk aversion. In this case, the uncertainty-managing motive for a TA is determined by interesting trade-offs. First, if income-risk aversion is sufficiently strong there is an uncertainty-reducing motive for a TA. Second, and more interestingly, for a given degree of risk aversion the uncertainty motive for a TA is more likely to be in the direction of reducing uncertainty when the economy is more open, when the export supply elasticity is lower and when the economy is more specialized.

We note that, empirically, lower-income countries tend to have lower export supply elasticities and a lower degree of diversification, thus at a broad level our model suggests that the uncertainty-reducing motive for a TA should be more important for lower-income countries than for higher-income countries.

Next we consider how the uncertainty motive for a TA is affected by changes in exogenous trade costs. We show that, if risk aversion is sufficiently strong, as the trade cost declines from its prohibitive level initially there is an uncertainty-increasing motive for a TA, but this turns into an uncertainty-decreasing motive as the trade cost becomes sufficiently low. Thus the

\textsuperscript{6}This feature is essentially due to the convexity of indirect utilities in prices, reflecting the ability of firms and consumers to make decisions after uncertainty is resolved, and has already been noted by others, e.g. Flemming et al [1977] and Eaton [1979]. Even though in this paper we focus on a competitive setting, we note that indirect utility functions and profit functions tend to be convex in prices even in the presence of imperfect competition and irreversible investments. See footnote 20 for further discussion.
model broadly suggests that uncertainty-reducing motives for TAs should emerge and become more important as the world becomes more integrated.

Next we examine the potential gains that a TA can provide by regulating trade-policy uncertainty, and compare them with the more standard gains from regulating the trade-policy mean. To this end, we isolate the latter gains by focusing on an “uncertainty-preserving agreement” (UPA), while the gains from regulating policy uncertainty are captured by the gains from a MPA. We consider local approximations of the gains from such agreements starting from the noncooperative policy schedule.

The most notable results concern how these gains depend on the underlying degree of uncertainty and on the exogenous trade cost. Regarding the degree of uncertainty, we find that an increase in the variance of the shock leads to larger gains from a MPA, while it does not affect the gains from a UPA, and as a consequence it implies larger overall gains from a TA. This in turn suggests that governments should have a higher propensity to sign a trade agreement when the trading environment is more uncertain.

Regarding the impact of trade costs, we show that the gains from an MPA, the gains from a UPA, and the ratio between these two are all non-monotonic in the trade cost. Furthermore, if trade costs are low enough that there is an uncertainty-reducing motive for a TA, further reductions in trade costs will tend to increase the gains from reducing trade-policy uncertainty and shrink the gains from reducing the trade-policy mean. Our model thus suggests that, as the world becomes more integrated, the gains from decreasing trade-policy uncertainty should tend to grow in absolute and relative terms.

Next we extend the model to allow for more general economic shocks. In this case, as mentioned above, in addition to the policy-risk-preference effect there may be a policy-externality-shifting effect. This latter effect operates through two possible channels: first, to the extent that the shock affects domestic economic conditions in Home, it will affect Foreign through terms-of-trade; and second, to the extent that the shock affects domestic economic conditions in Foreign, it will have a further impact on Foreign. In this case, it is possible that even if individuals are risk-neutral and hence the Foreign country is policy-risk loving, there may be an uncertainty-reducing motive for a TA.

We then provide a simple condition that can be used to determine the direction of the

\footnote{Specifically, a UPA is an agreement that shifts the tariff schedule \( t(\lambda) \) in a parallel fashion starting from the noncooperative schedule. This shift preserves all the higher central moments of the distribution of \( t \) (variance, skewness, kurtosis, etc.).}
uncertainty motive for a TA using parsimonious information. We start from the observation that the international externality exerted by Home’s tariff is given by an adjusted measure of Foreign’s openness, where the adjustment factor involves real per capita income and the degree of risk aversion, and show that there is an uncertainty-reducing motive if and only if, at the noncooperative equilibrium, the adjusted openness co-varies with the tariff as a result of the shocks. We emphasize that the sign of the co-variation between adjusted openness and tariff is sufficient to determine the sign of the uncertainty motive regardless of whether shocks are of the political-economy kind or of an “economic” nature.

We illustrate with a simple example how this “sufficient statistic” approach can be used in practice to check the direction of the uncertainty motive for a specific bilateral trading relationship, namely that between the US and Cuba in the period before their 1934 agreement. We find a positive correlation between US tariffs and Cuban adjusted openness, which suggests that indeed there was an uncertainty-reducing motive for a TA between US and Cuba before 1934. We do not want to take this quantification exercise too seriously, because our model is extremely stylized, but we think it suggests that the model can be taken to the data in a meaningful way, and it points to a potential direction for future research: developing richer versions of the model and taking them to richer datasets.

In our basic model, factors can be allocated only after uncertainty is resolved. In section 5 we extend the model to allow for ex-ante investments. We show that the conditions that determine the uncertainty motive for a TA in the presence of ex-ante investments are similar to those derived in the static model, provided the market allocation of capital is efficient given Home’s trade policy. The absence of a separate uncertainty motive associated with investment arises because, even though the TA can affect capital allocation, this has no first order effect on the Foreign objective, due to the efficiency of the allocation. Nevertheless, the optimal MPA does affect equilibrium investment and trade relative to the noncooperative equilibrium. For the case of political-economy shocks, we show that if income-risk aversion is sufficiently strong and the support of the shock sufficiently small, the optimal MPA will reduce trade policy uncertainty and increase investment in the export sector. Under those conditions we also find that the expected volume of trade increases, provided the export supply elasticity does not increase too rapidly with the price.

Finally, we extend the analysis to allow for two (symmetric) policy-active countries. The general condition for the optimal MPA to reduce trade policy uncertainty in this case still
includes the policy-risk-preference and externality-shifting effects. However, now there is an additional effect, which works in favor of an uncertainty-reducing motive if tariffs are strategic substitutes, and against it if they are strategic complements.

The increasing interest on TAs in the presence of uncertainty has generated a few papers, but their focus is very different from ours. Typically, they consider the implications of contracting imperfections (such as private or non-verifiable information, or contracting costs) and how they can explain certain design features of TAs. In contrast to these papers, we focus on the uncertainty-managing motive for a TA and the gains that a TA can provide by regulating policy uncertainty.

Also, there is a small but growing empirical literature on TAs and uncertainty. Cadot et al. (2011) show evidence that regional trade agreements reduce trade-policy volatility in agriculture. Rose (2004) and Mansfield and Reinhardt (2008) empirically examine the effect of TAs on the volatility of trade flows, but this is different from the volatility of trade policies. Finally, the impact of uncertainty-reducing trade agreements on trade flows and firms' investment into foreign markets is modeled and tested by Handley and Limão (2011) and Handley (2011). But whereas they take trade policy (before and after a trade agreement) as exogenous, we make it endogenous.

We structure the paper in the following way. In section 2 we lay out a basic framework with only one policy-active country, where government objectives are modeled in reduced-form fashion. In section 3 we consider a standard trade model with political economy shocks, and explore the determinants of the uncertainty motive for a TA and the gains from regulating policy uncertainty. In section 4 we extend the basic model to allow for more general economic shocks. In section 5 we allow for ex-ante investments and explore the impact of an uncertainty-reducing TA on investment and trade. In section 6 we extend the analysis to a setting with two policy-active countries. In section 7 we conclude. The Appendix contains the proofs of our results.

8 For example, Horn, Maggi and Staiger (2010), Amador and Bagwell (2011) and Beshkar and Bond (2010) show that the presence of uncertainty and contracting imperfections can explain the use of rigid tariff bindings (these imperfections take the form of contracting costs in Horn, Maggi and Staiger; of private information in Amador and Bagwell; and of costly state verification in Bond and Beshkar).

9 They also find that the WTO’s agricultural agreement reduced agricultural trade-policy volatility, in spite of the weak disciplines involved, but the effect is only weakly identified.
2. Basic framework

To make our points transparent, we start by focusing on a two-country setting where only one country is policy-active, hence there is a one-way international policy externality. In this section we model government objectives in reduced form as functions of a trade policy and of an underlying shock; in the next section we will “open up” the black box of government objectives in the context of a standard trade model.

There are two countries, Home and Foreign. The Home government chooses a trade policy $t$, while the Foreign government is passive (in section 6 we extend the model to allow for two policy-active countries). We let $\lambda$ denote a shock to the economic (or political-economy) environment, distributed according to the c.d.f. $F_\lambda(\lambda)$, with mean $\bar{\lambda}$ and variance $\sigma^2_\lambda$. This shock can affect Home, Foreign, or both. The Home government’s objective function is $G(t, \lambda)$. We assume $G$ is concave in $t$ and satisfies the single crossing property $G_{t\lambda} > 0$. The Foreign government’s objective is $G^*(t, \lambda)$, which we assume decreasing in $t$. The governments’ joint payoff is denoted $G^W(t, \lambda) = G(t, \lambda) + G^*(t, \lambda)$. We assume $G^W$ is concave in $t$ and satisfies the single crossing property $G^W_{t\lambda} > 0$.

One possible interpretation of this setting, which we will explore in the next section, is in terms of a two-sector perfectly-competitive world, where a large country trades with a small welfare-maximizing country and the TA is motivated by a TOT externality. But the reduced-form model we just introduced can in principle also be applied to settings where TAs may be motivated by other types of international externalities, such as non-TOT externalities of the kind emphasized by the "new trade" models of TAs (e.g. Ossa, 2011, Mrazova, 2012, Bagwell and Staiger, 2011).

We start by describing the non-cooperative policy choice. We assume the Home government observes $\lambda$ before choosing its trade policy, hence the noncooperative policy is given by:

$$t^N(\lambda) = \arg \max_t G(t, \lambda).$$

The single crossing property $G_{t\lambda} > 0$ implies that $t^N(\lambda)$ is increasing. The distribution of the shock, $F_\lambda(\lambda)$ and the shape of the $t^N(\cdot)$ schedule induce a distribution for the noncooperative policy $t^N$.

\[10\] In the literature on trade agreements there is a small tradition of models with a small country and a large country, a prominent example being McLaren (1997).
We now describe our assumptions regarding the trade agreement (TA). We assume that the agreement is signed ex ante, before $\lambda$ is realized, so the timing is the following: (0) the TA is signed; (1) $\lambda$ is realized and observed by both countries; (2) $t$ is implemented and payoffs are realized.

We assume the TA maximizes the governments’ expected joint payoff $EG^W$, so the optimal TA is given by

$$t^A(\lambda) = \arg \max \, EG^W(t, \lambda).$$

The single crossing property $G^W_{t\lambda} > 0$ implies that $t^A(\lambda)$ is increasing.

We assume that $\lambda$ is verifiable, so the agreement can be made contingent on $\lambda$. If the TA were non-contingent (i.e. "rigid") because of contracting imperfections (such as costs of specifying contingencies or imperfect verifiability), then the tariff would be fixed over some range of shocks. Thus contracting frictions tend to lower trade policy uncertainty as a mechanical side effect. This is surely a relevant effect in reality, but not a very interesting one, so we want to abstract from it, and ask instead whether there are deeper reasons why a TA might reduce trade policy uncertainty, rather than a side effect of contracting frictions. In other words, we want to examine whether there can be theoretical foundations to the informal argument that reducing trade policy uncertainty is a goal of trade agreements. For this reason we believe that a scenario of complete contingent contracting is the natural benchmark to consider.\(^\text{12}\)

Clearly, the noncooperative policy is inefficient because an international policy externality is present, and this motivates governments to sign a TA. When we introduce an explicit trade structure in the next section, this policy externality will operate via the terms-of-trade, but for now this can be interpreted as a more general international policy externality.

The international policy externality is transmitted through the whole distribution of $t$, so it is natural to distinguish two dimensions of such externality, a "mean externality" and an "uncertainty externality". The latter is the impact of a change in the degree of uncertainty in $t$ on Foreign’s expected welfare $EG^*$. The role of a TA is to address both of these dimensions, so conceptually we distinguish between a "mean motive" and an "uncertainty motive" for a TA.

\(^\text{11}\)This implicitly assumes that international transfers are available. Focusing on a transferrable-utility setting seems like a natural choice given that we are abstracting from any form of international transaction costs.

\(^\text{12}\)While, as we explained above, the reason for this assumption is to shut down contract rigidity as a possible cause of reductions in policy uncertainty, we note that the GATT-WTO includes a number of contingent clauses, for example the "escape clauses" in GATT Articles XIX and XXVIII. For a model that endogenizes the degree to which a trade agreement is contingent, based on the presence of contracting costs, see Horn, Maggi and Staiger (2010).
In order to isolate the uncertainty motive for a TA, we consider the following thought experiment: if we shut down the "mean motive" by constraining the TA to keep the average $t$ at the noncooperative equilibrium level, is there any role left for a TA? This is the idea behind our notion of "mean preserving agreement" (MPA). If the optimal MPA changes the riskiness of $t$ relative to the noncooperative tariff $t^N(\lambda)$, we say that there is an uncertainty-managing motive for a TA. And in this case, if the optimal MPA decreases (increases) the riskiness of $t$ relative to $t^N(\lambda)$, we say that there is an uncertainty-reducing (-increasing) motive for a TA.

Formally, the optimal MPA is defined as

$$t^{MPA}(\lambda) = \arg \max_{t(\lambda)} EG^W(t(\lambda), \lambda) \text{ s.t. } Et(\lambda) = Et^N(\lambda).$$

where the operator $E$ denotes an expectation over $\lambda$.

Before we study the optimal MPA, we provide some intuition by considering a local argument for the simplest possible case. Consider the case where $\lambda$ affects Foreign only through the policy $t$, so that its payoff is simply $G^*(t)$. This is the case if $\lambda$ is a pure preference shock for the Home government, which could be interpreted as a political economy shock.

Start from the noncooperative tariff $t^N(\lambda)$ and ask: how can we change the tariff schedule locally to achieve an increase in $EG^W = EG + EG^*$, while preserving the mean of the tariff? Since $t^N(\lambda)$ maximizes $EG$, a small change from $t^N(\lambda)$ will have a second-order effect on $EG$ and a first-order effect on $EG^*$. Clearly, then, to achieve an increase in $EG^W$ we must increase $EG^*$. Suppose $G^*$ is convex in $t$: then if we change the tariff schedule (slightly) such that the new tariff is a mean-preserving spread of $t^N(\lambda)$ then this will increase $EG^*$ (by the now standard Rothschild-Stiglitz, 1970, equivalence result) and thus $EG^W$ will also increase. Likewise, if $G^*$ is concave in $t$, we can achieve an increase in $EG^W$ by changing the tariff schedule in such a way that the new tariff is a mean-preserving compression of $t^N(\lambda)$. Therefore this argument suggests that the key condition determining whether the optimal MPA increases or decreases policy uncertainty is the concavity/convexity of the exporter’s objective with respect to the policy.

Of course, the argument above suggests only a sufficient condition for local improvement over the noncooperative outcome; in particular, one can improve over the noncooperative outcome in many other ways, including by changing the tariff schedule in ways that are neither a mean-preserving compression nor spread of $t^N(\lambda)$. But as we show below, this intuition does carry over to the globally optimal MPA (when the single crossing property is satisfied).
More importantly, however, the Rothschild-Stiglitz type argument above applies to the case of a pure “political-economy” shock in the importing country, but not if the shock affects the exporting country directly, not only through the policy \( t \). In this case, it is not enough to know whether the exporter’s objective is concave or convex with respect to \( t \) to determine how the optimal MPA will change policy uncertainty. In what follows, we will first derive the result formally, and then we will provide some intuition to highlight its basic logic.

To derive the FOCs for the optimal MPA problem in (2.1) we set up the Lagrangian:

\[
L = EG^W(t, \lambda) + \psi \left( Et^N(\lambda) - Et(\lambda) \right)
\]  \hspace{1cm} (2.2)

Since the multiplier \( \psi \) is constant with respect to \( \lambda \), we can rewrite the Lagrangian as follows

\[
L = \int [G^W(t, \lambda) + \psi t^N(\lambda) - \psi t(\lambda)] dF_\lambda(\lambda)
\]  \hspace{1cm} (2.3)

and since we can maximize this pointwise we obtain the following FOCs

\[
G^W_t(t(\lambda), \lambda) = \psi \text{ for all } \lambda
\]
\[
Et^N(\lambda) = Et(\lambda)
\]

Note that the FOC requires the marginal contribution of \( t \) to global welfare, \( G^W_t \), to be equalized across states (realizations of \( \lambda \)), and in particular \( G^W_t \) should be equal to the multiplier \( \psi \), which is easily shown to be negative. This will play a key role in our proofs below. Also note that the FOC for the unconstrained optimal agreement is given by \( G^W_t(t, \lambda) = 0 \), so both for the unconstrained optimum and for the optimal MPA, \( G^W_t \) is equalized across states, but in the former case it is equalized at zero, while in the latter case it is equalized at some negative constant.

Using the FOC we can prove:

**Lemma 1.** (i) If \( \frac{d}{d\lambda} G^*_t(t^N(\lambda), \lambda) < 0 \) \((> 0)\) for all \( \lambda \), then \( t^{MPA}(\lambda) \) intersects \( t^N(\lambda) \) once and from above (below). (ii) If \( \frac{d}{d\lambda} G^*_t(t^N(\lambda), \lambda) = 0 \) for all \( \lambda \), then \( t^{MPA}(\lambda) = t^N(\lambda) \) for all \( \lambda \).

Figure 1 illustrates Lemma 1 graphically for the case \( \frac{d}{d\lambda} G^*_t(t^N(\lambda), \lambda) < 0 \). The basic intuition for the result can be conveyed by focusing on the case in which \( \lambda \) can take only two values, say \( \lambda^H \) and \( \lambda^L \).

Let us start from the noncooperative schedule \( t^N(\lambda) \) and ask: how can we improve the ex-ante joint payoff? Given the mean-preservation constraint, there are only two
ways to deviate from $t^N(\lambda)$: decreasing $t$ for $\lambda = \lambda^H$ and increasing $t$ for $\lambda = \lambda^L$; or vice-versa. Recall that $t^N(\lambda)$ is increasing, that the marginal joint payoff is $G^W_t = G_t + G^*_t$, and that $G_t = 0$ at $t^N(\lambda)$. Now, if $\frac{d}{d\lambda} G^*_t(t^N(\lambda), \lambda) < 0$ then the marginal joint benefit of lowering $t$ for $\lambda = \lambda^H$ is higher than the marginal cost of raising $t$ for $\lambda = \lambda^L$, and hence this deviation improves the objective. Similarly, if $\frac{d}{d\lambda} G^*_t(t^N(\lambda), \lambda) > 0$ the objective can be improved by making the opposite deviation, that is by making the $t(\lambda)$ schedule steeper than $t^N(\lambda)$. And if $\frac{d}{d\lambda} G^*_t(t^N(\lambda), \lambda) = 0$, the marginal benefit of lowering $t$ for $\lambda = \lambda^H$ is equal to the marginal cost of raising $t$ for $\lambda = \lambda^L$, so a (marginal) deviation cannot improve the objective, and hence $t^N(\lambda)$ is the optimum. The proof of Lemma 1 (in Appendix) extends this basic logic to the case of continuous $\lambda$.

Note that Lemma 1 does not rely on the single crossing properties we assumed for $G$ and $G^W$, while the next result does.

Using Lemma 1 we derive our first proposition. In the proposition, we say that the optimal MPA reduces (increases) policy uncertainty if $t^{MPA}(\lambda)$ is a mean preserving compression (spread) of $t^N(\lambda)$.

**Proposition 1.** (i) If $\frac{d}{d\lambda} G^*_t(t^N(\lambda), \lambda) < 0$ ($> 0$) for all $\lambda$, then the optimal MPA reduces (increases) policy uncertainty relative to the non-cooperative equilibrium, hence there is an uncertainty-reducing (-increasing) motive for a TA. (ii) If $\frac{d}{d\lambda} G^*_t(t^N(\lambda), \lambda) = 0$ for all $\lambda$ then $t^{MPA}(\lambda) = t^N(\lambda)$, hence there is no uncertainty-managing motive for a TA.

Proposition 1 states that the presence of an uncertainty-managing motive for a TA is determined by how the shock $\lambda$ affects the international policy externality $G^*_t$, taking into account its direct effect and its indirect effect through the policy. In particular, if $G^*_t(t^N(\lambda), \lambda)$ is decreasing (increasing) in $\lambda$ there is an uncertainty-reducing (-increasing) motive for a TA. Writing $G^*_t(t^N(\lambda), \lambda) = G^*_t t^N + \frac{dN}{d\lambda} + G^*_t \lambda$ (where we use a superscript $N$ to indicate that a function is evaluated at $t^N(\lambda)$), the uncertainty motive for a TA can be traced to two key determinants: (i) Foreign’s policy-risk preference (captured by $G^*_t t^N$ and weighted by $\frac{dN}{d\lambda}$), and (ii) the direct impact of the shock $\lambda$ on the policy externality holding $t$ constant (as captured by $G^*_t \lambda$). Recalling that $G^*_t < 0$, when $G^*_t < 0$ the shock shifts “up” the marginal externality for given $t$ and works in favor of an uncertainty-reducing motive, and shifts it “down” if $G^*_t > 0$, so we refer to this as the *externality-shifting* effect.

Proposition 1 makes clear that the source of the uncertainty matters. In particular, we can
distinguish between two types of shock: (1) a “policy preference” (or “political economy”) shock, which affects the Foreign country only through policy uncertainty (in which case $G^* = G^* (t)$); and (2) an “economic” shock, which affects the Foreign country not only indirectly through the policy $t$ but also directly (in which case $G^* = G^* (t, \lambda)$).

Let us focus first on case (1). In this case, Proposition 1 says that the optimal MPA reduces policy risk if and only if $G^*_{tt} < 0$, so the uncertainty motive for a TA is determined solely by the Foreign government’s attitude toward foreign-policy risk. This confirms the initial intuition (described above) which is based on Rotschild and Stiglitz’s (1970) result: when Foreign’s objective is concave in $t$, a MPS in $t$ reduces $EG^*$, so there is a negative “risk externality” in trade policy, hence the noncooperative tariff is "too risky," and therefore there is value to an agreement that reduces that risk (with the opposite logic holding if Foreign’s objective is convex in $t$). We should highlight however that, even in this simpler case where the result is intuitive, it is far from self-evident. In principle the optimal MPA could lead to any mean-preserving change in the policy distribution relative to the noncooperative scenario, and since the MPS risk criterion is a partial ordering, it was not a priori obvious that the MPA distribution could be ranked in a MPS sense relative to the noncooperative distribution.\(^{13}\)

Next consider case (2), where the shock is of the “economic” type. In this case, the Rotschild-Stiglitz type intuition is no longer adequate: Proposition 1 states that the sign of $G^*_tt^N$ is no longer sufficient to determine whether the optimal MPA reduces or increases trade-policy risk. Interestingly, even though the only source of inefficiency in the noncooperative tariff is the international externality generated by the tariff, and the sign of the “risk externality” is given by the sign of $G^*_tt^N$, the sign of this externality does not uniquely determine whether there is “too much” or “too little” risk in the noncooperative tariff.\(^{14}\)

To highlight further how this case differs from the previous one and provide an alternative line of intuition, suppose that Foreign’s objective is linear in $t$ (i.e. $G^*_tt = 0$), so that Foreign is trade-policy-risk neutral. Suppose further that $G^*_tt^N < 0$, so that the (negative) international externality is stronger when $\lambda$ is higher. Then intuitively, since the MPA tariff must have the same mean as the noncooperative tariff, it is jointly preferable for the two countries to reduce.

\(^{13}\)Moreover, in the proof we show that if $G^*_tt < 0 (> 0)$ then the optimal MPA tariff is a “simple” mean preserving spread (compression) of the noncooperative tariff, meaning that the respective cdf’s cross only once.

\(^{14}\)Mathematically, the reason why the Rotschild-Stiglitz result cannot be applied here (so it is not necessarily true that if $G^*_tt > 0$ a mean preserving spread in $t$ increases $EG^*$), is that the Rotschild-Stiglitz result applies when utility is a function of a single random variable (in our case $G^* (t)$), while here $G^*$ is a function of two random variables, $t$ and $\lambda$, which are correlated.
the tariff in high-λ states, where the noncooperative tariff is higher, and increase it in low-λ states, where the noncooperative tariff is lower, thus the optimal MPA lowers trade policy uncertainty.

To summarize, if shocks are of the political-economy type, the sign of $G^N t$ is sufficient to determine the direction of the uncertainty-managing motive for a TA, but in the case of “economic” shocks this is no longer true, and the externality-shifting effect ($G^*_t$) comes into play.

Before concluding this section, we discuss an alternative thought experiment that one can consider to isolate the uncertainty motive for a TA. Suppose the Home government can choose a tariff schedule $t(\lambda)$ subject to the constraint $Et(\lambda) = Et^A(\lambda)$ (i.e. the chosen tariff must have the same mean as the optimal TA), and consider the resulting "mean preserving unilateral" choice:

$$t_{MPU}^U(\lambda) = \arg\max_{t(\lambda)} EG(t, \lambda) \text{ s.t. } Et(\lambda) = Et^A(\lambda).$$

If $t_{MPU}^U(\lambda)$ is more risky than $t^A(\lambda)$, then the noncooperative equilibrium involves "too much" policy risk, so we say that there is an uncertainty-reducing motive for a TA.

Applying a similar logic as for the MPA analysis, one can show that $t_{MPU}^U(\lambda)$ is a mean preserving spread of $t^A(\lambda)$, and hence there is an uncertainty-reducing motive for a TA, if $\frac{d}{d\lambda} G^*_t(t^A(\lambda), \lambda) < 0$. This condition is qualitatively similar to the one derived in the MPA analysis, and it confirms that the key determinant of the uncertainty motive for a TA is how the international externality $G^*_t$ varies with the shock $\lambda$, taking into account its direct effect and its indirect effect through the policy. But there is one important difference, namely that this condition is evaluated at the optimal agreement tariff $t^A(\lambda)$ rather than the noncooperative tariff $t^N(\lambda)$.

Note that if $\lambda$ affects Foreign’s objective only through the policy $t$, as in the case of a “political economy” shock, the condition becomes $G^*_t(\cdot)t^A'(\lambda) < 0$, or equivalently $G^*_t(\cdot) < 0$ (since $t^A'(\lambda) > 0$). Thus (recalling the assumption that $G^*_t$ does not change sign) the two thought experiments in this case yield the same answer, namely that there is an uncertainty-reducing motive for a TA if and only if the Foreign government is averse to foreign-policy risk.

If $\lambda$ is an “economic” shock, so that it affects Foreign’s objective not only through the policy $t$ but also directly, the condition becomes $G^*_t(\cdot)t^A'(\lambda) + G^*_{tA}(\cdot) < 0$. In this case, both thought experiments suggest that the uncertainty motive for a TA depends on Foreign’s policy-risk.
preference \( (G^*_{tt}) \) and on the externality-shifting effect \( (G^*_{tx}) \), but the relative weight of these two terms differs: in the MPA case \( G^*_{tt} \) is weighted by \( t^{N'}(\lambda) \), whereas in the MPU case it is weighted by \( t^A'(\lambda) \).\(^{15}\)

In what follows we base our analysis on the MPA thought experiment. The main reason is that, as we will show later, focusing on the MPA allows us to characterize the relative importance of the uncertainty motive in terms of quantities that can in principle be observed or estimated, while the MPU thought experiment does not share this property.\(^{16}\)

2.1. Gains from regulating policy uncertainty

Proposition 1 highlights conditions under which there is a policy-uncertainty-managing motive for a TA, and in this case, whether it calls for a reduction or an increase in policy uncertainty. Next we examine the magnitude of the gains that a TA can offer by regulating policy uncertainty, beyond the standard gains associated with regulating the policy mean. In this section we will derive general formulas for these gains, and in section 3 we will apply the formulas to a more structured trade model.

To isolate the gain from regulating policy uncertainty we ask what is the expected value of the optimal MPA relative to the noncooperative tariff choice \( t^N(\lambda) \), that is \( V^{MPA} = EG^W(t^{MPA}(\lambda), \lambda) - EG^W(t^N(\lambda), \lambda) \). We address the question by employing a local approximation approach: we consider a small mean-preserving change in the tariff schedule starting from \( t^N(\lambda) \) and evaluate the effect of this change on \( EG^W \). In particular, consider moving from \( t^N(\lambda) \) to \( t^N(\lambda) - \delta(\lambda - \bar{\lambda}) \), where \( \delta \) is a small constant. Clearly, if \( \delta > 0 \) (\( \delta < 0 \)) this represents a small mean-preserving compression (spread) of \( t^N(\lambda) \). Letting \( G^*_{tN}(\lambda) \equiv G^*_{t}(t^N(\lambda), \lambda) \), the resulting change in \( EG^W \) can be approximated as follows:

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\(^{15}\)As we will show in the next section, if the shock originates in the Home country and affects Foreign only through terms of trade (and since by assumption \( G^*_{tt} \) and \( G^*_{tx} \) do not change sign), then \( \frac{d}{dt}G^*_{t}(t(\lambda), \lambda) \) has the same sign regardless of whether it is evaluated at \( t^N(\lambda) \) or at \( t^A(\lambda) \); so in this case the two thought experiments yield the same qualitative answer. But if the shock affects both countries directly, then the two thought experiments may give different answers.

\(^{16}\)To be more specific, we approximate the value of a small MPA starting from the noncooperative tariff, which is in principle observable. But we do not observe the MPU tariff so in order to approximate the value of a small mean preserving change around an observable situation we would need to do so around the optimal agreement. However, small changes around this tariff have no first-order effect on the joint payoff.
In the second line of (2.4) we have used the fact that \(G_t = 0\) at the Nash tariff; in the third line we have used a first-order Taylor approximation of \(G_t^N(\lambda)\) around \(\bar{\lambda}\) and \(\frac{d G_t^N(\lambda)}{d\lambda}\) as shorthand for \(\left(\frac{d G_t^N(\lambda)}{d\lambda}\right)_{\lambda = \bar{\lambda}}\).

The expression in the last line of (2.4) is intuitive: it states that the value of the MPA is the product of two components, the sensitivity of the policy externality to the shock \(\frac{d G_t^N(\lambda)}{d\lambda}\), which from Proposition 1 determines the direction of the uncertainty-managing motive, and the variance of \(\lambda\).

Since the sign of \(\delta\) can be chosen to ensure a positive gain, we can write the approximate value of the MPA as

\[
\tilde{V}_{MPA} = \left[\frac{d G_t^N(\bar{\lambda})}{d\lambda}\right] \cdot \sigma^2_{\lambda} \quad (2.5)
\]

Next we focus on the more standard gains from managing the mean level of the tariff. A natural approach is to define an “uncertainty-preserving agreement” (UPA) in the following way. Consider a parallel downward shift of the \(t^N(\lambda)\) schedule, say \(t^N(\lambda) - \kappa\), where \(\kappa\) is a positive constant. Note that the schedule \(t^N(\lambda) - \kappa\) has the same central higher moments as \(t^N(\lambda)\) (variance, skewness, kurtosis), but a lower mean, so the UPA keeps the mean tariff constant but allows the rest of the tariff distribution to change.

Following similar steps as above, we can derive the approximate value of the UPA:

\[
\tilde{V}_{UPA} = \left. \frac{\partial E[G^W(t^N(\lambda) - \kappa, \lambda)]}{\partial \kappa} \right|_{\kappa = 0} = -E[G_t^N(\lambda)] \quad (2.6)
\]

Intuitively, the gain from reducing the mean tariff level is approximately equal to the gain from reducing the tariff from its Nash level in the absence of uncertainty (that is, if \(\lambda\) is fixed at \(\bar{\lambda}\)), which in turn is given by the marginal externality that the tariff exerts on the Foreign country.
Therefore the relative gain from managing tariff uncertainty versus managing the tariff mean is:

\[
\frac{\tilde{V}^{MPA}}{V^{UPA}} = \left| \frac{d \ln G^N_t(\bar{\lambda})}{d\lambda} \right| \cdot \sigma^2
\]  

(2.7)

This expression can be interpreted as saying that the relative importance of the uncertainty motive versus the mean motive for a TA is given by the elasticity of the international externality with respect to the shock \(\lambda\), scaled by the degree of uncertainty in the economic/political environment.

Finally, we may ask what is the (approximate) overall value of a TA, that is the value of a partial move toward the optimal agreement starting from the noncooperative tariff. The answer is a simple corollary of the analysis above: the value of a small joint improvement in tariff mean and tariff uncertainty is a weighted average of expressions (2.4) and (2.6) above, with the weights determined by the relative change in \(\delta\) and \(\kappa\). Thus, if a certain parameter change increases (weakly) both the value of an MPA and the value of a UPA, it will also increase (weakly) the value of the overall TA. Below we will highlight the implications of this observation within our economic structure.\(^{17}\)

3. Uncertainty and mean motives in a standard trade model

We now open up the black box of government objectives in order to examine how the uncertainty and mean motives for a TA depend on economic fundamentals. Our basic model focuses on the case in which shocks are of the "political economy" type. We will later extend the analysis to the case of more general "economic" shocks.

In keeping with the basic framework above, we consider a standard two-country, two-good trade model with competitive markets. Assume Home is the natural exporter of the numeraire good, indexed by 0, while Foreign (the small country) is the natural exporter of the other good, which has no index.

Let \(p\) (resp. \(p^*\)) denote the price of the nonnumeraire good in Home (resp. Foreign). We will often use the logarithms of prices, so let \(\pi \equiv \ln p\) and \(\pi^* \equiv \ln p^*\). The Home country can

\(^{17}\)One further question one may ask is: Under what conditions are the uncertainty and mean motives for a TA complements or substitutes? That is, when is the optimal TA more valuable than the sum of its two parts, or \(V^A > V^{MPA} + V^{UPA}\)? This in general can go either way depending on the third derivatives \(G^W_{ttt}\) and \(G^W_{t\lambda\lambda}\). The standard trade model we are considering has no clear implications for the signs of these derivatives, and hence does not yield clear-cut predictions on whether the uncertainty and mean motives for a TA are complements or substitutes.
choose an ad-valorem tariff on imports of the non-numeraire good. Let \( t \equiv \ln \tau \), where \( \tau \) is the ad-valorem tariff factor. We also allow for an exogenous iceberg trade cost; let \( \gamma \) denote the logarithm of such trade cost. The reason we allow for trade costs is not only that such costs are important empirically, but because they will play an important role in determining the gains from regulating policy uncertainty, as will become clear below. By the usual arbitrage condition, if the tariff is not prohibitive then we must have \( \pi^* = \pi - t - \gamma \). Since Foreign has no policy of its own, we can refer to \( \pi^* \) as the “terms of trade” (TOT). We will interpret \( \lambda \) as the log of the underlying shock so \( t'(\lambda) \) can be interpreted as the elasticity of the tariff factor with respect to the shock; in what follows we let \( \varepsilon^*_t \) denote this elasticity.

The reason we use the logarithms of the relative price, the tariff rate and the trade cost is the following. In general equilibrium settings with uncertainty about relative prices, the conventional notion of risk based on arithmetic mean-preserving spread of relative prices leads to predictions that are sensitive to the choice of numeraire (see for example Flemming et al, 1977). These scholars have argued that a more robust approach is to define an increase in relative-price risk as a geometric mean preserving spread (GMPS) of the relative price, which is an arithmetic mean preserving spread of the log of the relative price (in our notation, \( \pi^* \)). For analogous reasons we define the trade policy as the log of the tariff rate.

We let \( x^*(\pi^*) \) denote Foreign’s export supply curve and \( m(\pi, t) \) denote Home’s import demand function. Note that \( m \) depends not only on the domestic price \( \pi \) but also on \( t \), since the tariff affects revenue and hence income. We will keep the transport cost in the background of our notation. The market clearing condition \( x^*(\pi^*) = m(\pi^* + t, t) \) determines the equilibrium TOT as a function of the policy, \( \pi^* (t) \). Note that since Foreign is small, the incidence of the tariff falls entirely on Foreign, hence \( \pi^* (t) = \pi - t \).

We next impose some standard assumptions on preferences and technology. To make the key points we only need to specify the economic structure in the Foreign country. On the technology side, we assume CRS with a strictly concave PPF, so that supply functions are strictly increasing. This allows us to represent technology through a GDP (or revenue) function. Letting \( p^* \) be the domestic relative price and \( (q_0^*, q^*) \) the outputs, we define \( R^*(p^*) \equiv \max_{q_0^*, q^*} \{q_0^* + p^* q^* \} \) s.t. \( (q_0^*, q^*) \in Q^* \), where \( Q^* \) is the set of feasible outputs.

Note that we allow for any number of production factors. But also note that, by assuming a strictly concave PPF, we are implicitly assuming that at least some production factors are flexible, in the sense that they can be allocated ex-post after the shock \( \lambda \) is realized.
On the preference side, we assume that all citizens have identical and homothetic preferences. This implies that indirect utility takes the form $U_y(p)$, where $y$ is income in terms of numeraire and $\phi(p)$ a price index. It is natural to refer to $\frac{y}{\phi(p)}$ as individual $j$'s "real income". For the purposes of comparative statics it is convenient to parametrize the degree of risk aversion, so we assume that $U(\cdot)$ exhibits constant relative risk aversion (CRRA), indexed by the parameter $\theta$. We further assume that all citizens have identical factor endowments, we normalize the population measure to one, and assume that the Foreign government maximizes social welfare, so we can write

$$G^* = \frac{1}{\theta} \left( \frac{R^*(p^*)}{\phi^*(p^*)} \right)^\theta$$

Finally, we assume that Foreign exports the nonnumeraire good for all values of $\lambda$ in its support (and hence for all values of $p^*$ in its support), or in other words, the trade pattern cannot switch as a result of the shock.

As made clear by the analysis of section 2, the key to gauge the uncertainty motive for a TA is to consider how the marginal international externality exerted by the Home tariff, $G_t^*$, responds to the shock $\lambda$. In our model Home’s tariff exerts only a TOT externality on Foreign welfare, given by

$$G_t^* = -v^* \cdot \Omega^*$$

where $v^* = \frac{R^*}{\phi^*}$ is Foreign’s real income and $\Omega^* = \frac{v^*}{R^*}$ is Foreign’s degree of openness (export to GDP ratio). Intuitively, the degree of openness $\Omega^*$ captures the impact of an increase in $t$ on Foreign’s real income through TOT, and the factor $v^* \theta$ is related to the marginal utility of income: with $\theta < 0$, the externality is stronger when real income ($v^*$) is lower (for a given level of openness), because the marginal utility of income is then higher. In what follows we will refer to $v^* \theta \Omega^*$ as the “adjusted” degree of openness.

We start by focusing on the benchmark case of income-risk neutrality.

Since we are adopting the GMPS notion of risk (as we discussed above), it is natural to define risk neutrality as indifference with respect to a GMPS of real income, which corresponds to the case: $V^* = \ln (y^*/\phi^*)$, or $\theta \to 0$ in the CRRA specification. Thus in this case the government’s objective is $G^* = \ln \left( \frac{R^*(p^*)}{\phi^*(p^*)} \right)$, and the international externality is simply $G_t^* = -\Omega^*$.

The key step to apply Proposition 1 when only political economy shocks are present is to examine the Foreign country’s attitude toward foreign-policy risk, as captured by $G_{tt}^*$. This is

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18Here we are implicitly making the standard assumption that consumption occurs after prices are observed.
given by the impact of $t$ on adjusted openness, which is easily shown to be

$$G^*_t |_{\theta=0} = \Omega^* (\varepsilon^*_x + D^*),$$

where $\varepsilon^*_x$ is the export supply elasticity and $D^* \equiv 1 - \frac{\varepsilon^*_q}{R^*}$ is the GDP share of the import-competing sector, which can be interpreted as the degree of income diversification.

We will assume throughout that $\varepsilon^*_x$ is nonnegative. Given this assumption, it follows that $G^*_t |_{\theta=0} > 0$: thus, in the case of income-risk neutrality, the Foreign country benefits from an increase in foreign-policy risk. The intuition for this feature is that the ability to adjust production and consumption ex-post tends to make the indirect utility convex in prices. This insight in itself is not new to our model, and was pointed out for example by Eaton (1979); what is new is that in light of Proposition 1, the convexity of $G^*$ with respect to $t$ implies that the optimal MPA increases trade-policy uncertainty.

To summarize, if individuals are income-risk neutral, there is an uncertainty-managing motive for a TA, but this calls for an increase – rather than a decrease – in trade-policy uncertainty.

We regard this result as an interesting “puzzle” that arises in the standard trade model with income-risk neutrality. Evidently, if one wants to make economic sense of the WTO-type informal arguments discussed in the introduction, which state that one of the goals of TAs is to reduce trade policy uncertainty, one must depart from the benchmark case of income-risk neutrality and focus on the case of income-risk aversion ($\theta < 0$), which is what we do next.

Let us now examine the Foreign country’s preference for trade-policy risk allowing for income-risk aversion ($\theta < 0$). Recalling that the international externality from the tariff

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19 There is considerable empirical evidence that this is the case in reality for most sectors and most countries (see for example Tockarick, 2010).

20 It is important to note that this “puzzle” extends well beyond the simple perfectly-competitive setting we are considering here. In particular, one might wonder whether the presence of imperfect competition or irreversible investments might make exporting firms’ profit functions concave in prices, but even in these circumstances profit functions are typically convex in prices. The intuitive reason is that profit functions are convex whenever firms can make any ex-post adjustment in their production decisions after observing the realization of the shock, and this feature is extremely general. As an example, consider Handley and Limão’s (2011) setting where exporting firms face uncertainty and make irreversible investments: in that setting as well, profit functions are convex in prices.

21 Note that, even with income risk aversion, in the Foreign country there is still no motive for trade protection, so our assumption that this country practices free trade continues to be without loss of generality given the representative-citizen assumption. As Eaton and Grossman (1985) made clear, in a small country an insurance motive for trade protection can arise only if citizens have heterogenous incomes, at least ex-post. In our setting, Foreign citizens are always homogenous, even ex-post. This will be true also in the next section, where we consider a dynamic setting with ex-ante investments.
is given by \( G_t = -v^\theta \cdot \Omega^* \) and differentiating this expression with respect to \( t \), we obtain

\[
G_{tt} = v^\theta \Omega^* (\theta \Omega^* + \varepsilon_x^* + D^*). \tag{3.2}
\]

This expression (which is derived in Appendix within the proof of Proposition 2), together with the result of Proposition 1, leads to:

**Proposition 2.** The optimal MPA reduces trade-policy uncertainty relative to the noncooperative equilibrium, and hence there is an uncertainty-reducing motive for a TA, if \( \theta \Omega^* + \varepsilon_x^* + D^* < 0 \) at the noncooperative equilibrium. The reverse is true if \( \theta \Omega^* + \varepsilon_x^* + D^* > 0 \) at the non-cooperative equilibrium.

There are several aspects of Proposition 2 that are worth highlighting. First, if income-risk aversion is sufficiently high relative to the other parameters of the model (namely if \( \theta < \frac{-\varepsilon_x^* + D^*}{\Omega^*} \), where the right hand side is evaluated at the non-cooperative equilibrium), then there is an uncertainty-reducing motive for a TA. While this statement is not too surprising in itself, the impact of the other variables on the uncertainty motive is more subtle.

Proposition 2 states that, for a given degree of risk-aversion \( \theta < 0 \), the uncertainty motive for a TA is more likely to be in the direction of reducing policy uncertainty when: (a) the economy is more open (\( \Omega^* \) is higher); (b) the export supply elasticity \( \varepsilon_x^* \) is lower; and (c) the economy is more specialized (\( D^* \) is lower).\(^{22}\)

Start by focusing on the degree of openness \( \Omega^* \). This variable affects the uncertainty motive through its interaction with the income-risk preference parameter \( \theta \), so the role of openness in essence is to magnify the impact of the citizens’ income-risk preference.

Next consider the role of the export supply elasticity \( \varepsilon_x^* \). Intuitively, a country that experiences larger ex-post adjustments in production and consumption as a result of the shocks (that is, a country with a higher \( \varepsilon_x^* \)) is more likely to have a welfare function that is convex in

\(^{22}\)Here we can make the statements in the text a bit more precise. First, when we say that the uncertainty motive is “more likely” to be in the direction of reducing policy uncertainty when a variable \( x \) is higher, we mean that as \( x \) increases the sign of \( G_{tt}^{\infty} \) can switch from negative to positive but not vice-versa. Second, in the text we talk about changes in \( \Omega^* \), \( D^* \) and \( \varepsilon_x^* \) as if these variables were exogenous, but of course they are not. To make our statements more precise, let \( \xi \) denote the vector of all technology and preference parameters (excluding \( \theta \)). We can think of the key endogenous variables \( \Omega^* \), \( D^* \) and \( \varepsilon_x^* \) as functions of \( \xi \). Note that \( \theta \) does not affect these variables. Next note that \( \Omega^* \in [0, 1] \) and \( D^* \in [0, 1] \), while \( \varepsilon_x^* \geq 0 \) by assumption. In the text, when we refer to a change in an endogenous variable, we mean that the parameter vector \( \xi \) is being changed in such a way that the variable of interest changes while the others do not. If we include in \( \xi \) the whole technology and preference structure, by varying \( \xi \) we can span the whole feasible range of \( \Omega^* \), \( D^* \) and \( \varepsilon_x^* \), so this "all else equal" thought experiment can be performed.
the foreign tariff, and hence is less likely to benefit from a decrease in tariff uncertainty. This in turn suggests a couple of interesting implications. First, since production factors are more mobile in the long run, \( \varepsilon_x^+ \) tends to be higher in the long run than in the short run, and this in turn implies that the uncertainty-reducing motive for a TA is less important the longer the time horizon of the TA. Second, at the empirical level, lower-income countries tend to have lower export supply elasticities,\(^{23}\) and this in turn implies that the uncertainty-reducing motive for a TA should be more important for lower-income countries than for higher-income countries.

Focus next on the degree of diversification \( D^* \). Proposition 2 indicates that, other things equal, the uncertainty motive for a TA is more likely to be in the direction of reducing policy uncertainty if Foreign is less diversified. A related remark is that, for a given \( \theta < 0 \), if preferences are Cobb-Douglas and the economy is sufficiently specialized (\( D^* \) is sufficiently close to zero), then the optimal MPA can be shown to reduce policy uncertainty.\(^{24}\) Interestingly, this observation goes in the same direction as the one we made above about \( \varepsilon_x^+ \): to the extent that lower-income countries are more likely to be specialized in production, our model predicts that the uncertainty-reducing motive for a TA should tend to be more important for lower-income countries.

Finally, it is interesting to consider the impact of the exogenous trade cost \( \gamma \), which we have thus far left in the background. A preliminary observation is that a decrease in \( \gamma \) leads to an increase in the degree of openness \( \Omega^* \) and a decrease in the degree of diversification \( D^* \); this is intuitive, since the decrease in \( \gamma \) affects Foreign only through an increase in \( p^* \), which leads to a reallocation of resources toward the export sector. We consider the following thought

\(^{23}\)See for example Tockarick (2011), who estimates that the median export supply elasticity is 0.52 for low income countries, 0.77 for low/medium income countries, 0.83 for medium/high income countries, 0.92 for high income non-OECD countries, and 1.14 for high income OECD countries. (Tockarick bases his estimates on a standard trade model for a small economy with one export good, one import good and one non-trade good, with no own consumption of the export good.)

\(^{24}\)The statement in the text is easily proved. Recall that the optimal MPA reduces policy uncertainty if \( \theta < -\varepsilon_x^+ D^* \). If the country is fully specialized, \( \frac{\partial^2 \Omega^*}{\partial \varepsilon_x^+ \partial D^*} = 1 \), hence \( D^* = 0 \). Next note that Cobb-Douglas preferences and complete specialization imply \( \varepsilon_x^+ = 0 \). To see this, write \( \varepsilon_x^+ = \frac{\partial^2 \Omega^*}{\partial \varepsilon_x^+} - \frac{\partial^2 \Omega^*}{\partial \varepsilon_c^+} \varepsilon_c^+ \), where \( \varepsilon_c^+ \) is the elasticity of \( q^* \) with respect to \( p^* \) and \( \varepsilon_c^+ \) is the elasticity of \( c^* \) with respect to \( p^* \), and note that (i) \( c^* = \frac{\partial R^*}{\partial p^*} \), where \( \alpha \) is the consumption share of the non-numeraire good, hence \( \varepsilon_c^+ = \frac{\partial \ln R^*}{\partial \ln p^*} - 1 \); but \( d \ln R^* / d \ln p^* = R^*/p^* = 1 \) (where we have used the fact that \( R^*_p = q^* \)), hence \( \varepsilon_c^+ = 0 \); (ii) if the economy is fully specialized, a small increase in \( p^* \) cannot lead to any change in \( q^* \), since all resources are already in the non-numeraire sector, hence \( \varepsilon_x^+ = 0 \). It follows that \( \varepsilon_x^+ = 0 \). And since \( \Omega^* > 0 \), then in a fully specialized economy \( \frac{\partial^2 \Omega^*}{\partial \varepsilon_x^+ \partial D^*} = 0 \). Finally, assuming that \( \varepsilon_x^+ (p^*) \) is continuous for all \( p^* \), as the economy becomes fully specialized \( \frac{\partial^2 \Omega^*}{\partial \varepsilon_x^+ \partial D^*} \) approaches zero, so we can conclude that for any fixed \( \theta < 0 \) the condition \( \theta < -\varepsilon_x^+ D^* \) is satisfied if the economy is sufficiently specialized.
experiment. Let $\gamma_{prohib}$ be the level of $\gamma$ at which there is no trade ($\Omega^* = 0$), and consider the effect of decreasing $\gamma$ from $\gamma_{prohib}$ to zero. Suppose risk aversion is strong enough that in the absence of trade costs there is an uncertainty-reducing motive (that is, $\theta < \left( \frac{-\varepsilon^*_x + D^*}{\Omega} \right)_{\gamma=0}$).

Clearly, as $\gamma$ drops below $\gamma_{prohib}$, Initially the uncertainty motive for a TA goes in the direction of increasing policy uncertainty (because $\theta \Omega^*$ is negligible and hence dominated by $\varepsilon^*_x + D^*$), but as $\gamma$ drops further, the direction of the uncertainty motive will at some point reverse and call for a reduction in policy uncertainty. Thus we can state:

**Remark 1.** Assume risk aversion is sufficiently strong, in the sense that $\theta < \left( \frac{-\varepsilon^*_x + D^*}{\Omega} \right)_{\gamma=0}$. If the trade cost $\gamma$ is close enough to its prohibitive level, there is an uncertainty-increasing motive for a TA ($\theta \Omega^* + \varepsilon^*_x + D^* > 0$), while if $\gamma$ is close enough to zero there is an uncertainty-decreasing motive for a TA ($\theta \Omega^* + \varepsilon^*_x + D^* < 0$).

If $\varepsilon^*_x$ does not decrease too fast with $\gamma$, we can make the additional statement that $\theta \Omega^* + \varepsilon^*_x + D^*$ is monotonic in $\gamma$ and will switch sign exactly once. If on the other hand $\varepsilon^*_x$ decreases quickly with $\gamma$, then $\theta \Omega^* + \varepsilon^*_x + D^*$ may not be monotonic, but the result in Remark ?? is still valid.

To sum up, if one believes that exogenous trade costs have been declining over time, the model broadly suggests that uncertainty-reducing motives for TAs should emerge and become more important as the world becomes more integrated. We will come back to this theme in the next section, where we consider the potential gains from regulating trade-policy uncertainty.

### 3.1. Gains from regulating policy uncertainty in a standard trade model

In this section we examine the gains that a TA can offer by regulating trade-policy uncertainty and compare them with the more standard gains from regulating the trade-policy mean. To this end, we apply the general formulas developed in section 2.1.

Given that the political economy shock $\lambda$ affects Foreign welfare only through Home’s tariff $t$, we have $\frac{dG^N(t^N(\bar{\lambda}))}{d\lambda} = G^*_t(t^N(t^N(\bar{\lambda})) \cdot \varepsilon^*_x$. Plugging the expression for $G^*_t$ and $G^*_tt$ developed above in the general formulas of section 2.1, we obtain:

**Proposition 3.** (i) The approximate value of an MPA starting from the noncooperative equilibrium is

$$V_{MPA} \approx |\theta \Omega^* + \varepsilon^*_x + D^*| \cdot \left( v^{*\theta} \Omega^* \right) \cdot \varepsilon^*_x \cdot \sigma^2$$

(3.3)
(ii) The approximate value of a UPA starting from the noncooperative equilibrium is
\[ \hat{V}^{UPA} \approx v^* \Omega^* \] (3.4)

(iii) The relative value of an MPA versus a UPA is:
\[ \frac{\hat{V}^{MPA}}{\hat{V}^{UPA}} \approx |\theta \Omega^* + \varepsilon^*_x + D^*| \cdot \varepsilon^*_x \cdot \sigma^2_\lambda \] (3.5)

where all expressions are evaluated at the noncooperative tariff.

Proposition 3 provides an approximation of the potential gains that a TA can offer by managing trade policy uncertainty, in absolute terms (part (i)), and relative to the gains from managing the trade policy mean (part (iii)).

It is worth highlighting the role of two key determinants of these gains: the variance of the shock, \( \sigma^2_\lambda \), which can be interpreted as capturing the degree of uncertainty in the political/economic environment, and the exogenous trade cost \( \gamma \).

Focus first on the role of \( \sigma^2_\lambda \). Other things equal, when \( \sigma^2_\lambda \) is higher the importance of the uncertainty motive for a TA, as captured by \( \hat{V}^{MPA} \), is higher.\(^{25}\) On the other hand, \( \sigma^2_\lambda \) has no impact on the mean motive for a TA, as captured by \( \hat{V}^{UPA} \). And as we discussed at the end of section 2.1, these observations imply that a higher \( \sigma^2_\lambda \) leads to larger overall gains from a TA.\(^{26}\) Thus, at a broad level, our model suggests that governments should have stronger incentives to sign trade agreements when the trading environment is more uncertain.

Next focus on the impact of the trade cost \( \gamma \). Consider first how \( \gamma \) affects the relative gains from regulating policy uncertainty (\( \hat{V}^{MPA}/\hat{V}^{UPA} \)). Continue to assume \( \theta < \left( -\frac{\varepsilon^*_x + D^*}{\Omega^*} \right) \) as in the previous section. As observed above, \( \Omega^* \) is decreasing in \( \gamma \) and \( D^* \) is increasing in \( \gamma \). This implies that there exists a critical level of \( \gamma \), say \( \gamma^* \), for which \( \theta \Omega^* + \varepsilon^*_x + D^* = 0 \). To simplify our argument, we assume that such critical level \( \gamma^* \) is unique. Under this assumption, it is clear

\(^{25}\)Note that \( \sigma^2_\lambda \) has no impact on any of the other variables that appear in \( \hat{V}^{MPA} \) or \( \hat{V}^{UPA} \), including \( \xi^*_\lambda \). This is because in the noncooperative equilibrium Home chooses the tariff after observing \( \lambda \), so the schedule \( t^N(\lambda) \) does not itself depend on \( \sigma^2_\lambda \).

\(^{26}\)This point can also be made by looking at the full gains from the optimal TA, if one is willing to approximate the payoff functions with quadratic functions. To see this, write the value of the optimal TA as \( E[G^W(t^A(\lambda), \lambda) - G^W(t^N(\lambda), \lambda)] \). Clearly, a mean preserving spread in \( \lambda \) increases this value if and only if \( G^W(t^A(\lambda), \lambda) - G^W(t^N(\lambda), \lambda) \) is convex in \( \lambda \). Assuming that all third derivatives of \( G \) and \( G^W \) are zero, this is the case if \( G^W_{tt}(t^A) + 2G^W_{tA} t^A - \left( G^W_{tt}(t^N) + 2G^W_{tA} t^N \right) > 0 \). Using \( t^A = -\frac{G^W_{tA}}{G^W_{tt}} \) and simplifying, this condition becomes \( (t^A - t^N)^2 > 0 \), which is always satisfied if \( t^A \neq t^N \).
that \( \frac{\tilde{V}_{MPA}}{\tilde{V}_{UPA}} \) must be non-monotonic in \( \gamma \), with a minimum value of zero. To see this, consider lowering \( \gamma \) from its prohibitive level \( \gamma^{prohib} \) towards zero: initially, when \( \gamma \) is close to \( \gamma^{prohib} \), the relative gain \( \frac{\tilde{V}_{MPA}}{\tilde{V}_{UPA}} \) is strictly positive (with the gains from the MPA coming from an increase in uncertainty); when \( \gamma \) reaches \( \hat{\gamma} \), the ratio \( \frac{\tilde{V}_{MPA}}{\tilde{V}_{UPA}} \) reaches zero, and as \( \gamma \) falls further \( \frac{\tilde{V}_{MPA}}{\tilde{V}_{UPA}} \) becomes strictly positive again, but this time with the gains from the MPA coming from a decrease in uncertainty.

Next we focus on how the trade cost \( \gamma \) affects the more standard gains from decreasing the mean tariff, \( \tilde{V}_{UPA} \). The key is to note that a change in \( \gamma \) has the same impact on the adjusted openness \( v^*\Omega^* \) as a change in \( t \), so \( \frac{d}{d\gamma}(v^*\theta\Omega^*) = \frac{d}{dt}(v^*\theta\Omega^*) \), and we already know that \( \frac{d}{dt}(v^*\theta\Omega^*) < 0 \) if and only if \( \theta\Omega^* + \epsilon^*_x + D^* < 0 \), which by our definition of \( \hat{\gamma} \) is the case when \( \gamma < \hat{\gamma} \). Thus we can conclude that, as \( \gamma \) drops from its prohibitive level, \( \tilde{V}_{UPA} \) initially rises, then reaches a maximum at \( \gamma = \hat{\gamma} \), and subsequently falls. Thus we can state:

**Remark 2.** (i) The relative gains from regulating policy uncertainty (\( \frac{\tilde{V}_{MPA}}{\tilde{V}_{UPA}} \)) are non-monotonic in \( \gamma \), with a minimum value of zero at \( \gamma = \hat{\gamma} \). (ii) The gains from decreasing the tariff mean (\( \tilde{V}_{UPA} \)) are non-monotonic in \( \gamma \), reaching a maximum at \( \gamma = \hat{\gamma} \).

This result suggests that, when trade costs are low enough that there is an uncertainty-reducing motive for a TA (\( \gamma < \hat{\gamma} \)), further reductions in trade costs will tend to increase the gains from reducing trade-policy uncertainty and shrink the gains from reducing the trade-policy mean. Thus, at a broad level, our model predicts that, as the world becomes more integrated, the gains from decreasing trade-policy uncertainty should tend to grow in absolute and relative terms.

### 3.2. Impact of MPA on trade volume

Next we ask: what is the impact of the optimal MPA on the expected volume of trade? To fix ideas, suppose that the optimal MPA reduces trade policy uncertainty. Note that trade volume can be written as \( x^*(\pi^*) \), so the change in expected log trade due to the MPA is

\[
\int \ln x^*(\pi^*) d\left(F_{MPA}(\pi^*) - F_N(\pi^*)\right),
\]

where \( F_N(\pi^*) \) (resp. \( F_{MPA}(\pi^*) \)) is the distribution of \( \pi^* \) induced by \( t^N(\lambda) \) (resp. \( t^{MPA}(\lambda) \)). By standard Rothschild-Stiglitz logic, it is immediate to conclude that expected trade increases as a result of the MPA if and only if Foreign’s export supply elasticity \( \epsilon^*_x \) is decreasing in \( \pi^* \). Also note that the same conclusion applies to the (log) trade value \( \pi^* + \ln x^*(\pi^*) \), since an MPA keeps \( E(t) \) and thus \( E(\pi^*) \) unchanged.
In general the export supply function can have increasing or decreasing elasticity, so this is ultimately an empirical question. It is interesting to relate this analysis with a central result of the TOT theory of trade agreements, highlighted by Bagwell and Staiger (1999) and other papers by the same authors, namely that TAs always expand trade between countries. Thus the mean motive for TAs has an unambiguous expanding impact on trade. In contrast, the uncertainty motive for TAs in general may impact trade volume in either direction.\(^{27}\)

There is a special but interesting case where the model yields a more definite prediction concerning the impact of a decrease in trade policy uncertainty on expected trade. This is the same case we considered above when highlighting that an uncertainty-reducing motive is more likely to be present for lower-income countries. We showed above that, if preferences are Cobb-Douglas and Foreign is sufficiently specialized, then the optimal MPA reduces policy uncertainty for any \(\theta < 0\). In this case, the export supply elasticity \(\varepsilon_x^*\) must be decreasing in \(\pi^*\) around the point of full specialization, since it is zero if the country is fully specialized (and we assumed \(\varepsilon_x^* \geq 0\)). As a consequence, a decrease in policy uncertainty increases expected trade. This suggests that countries heavily specialized in commodities are not only more likely to benefit from a reduction in policy uncertainty, as we argued above, but also more likely to experience an increase in expected trade as policy uncertainty decreases.\(^{28}\)

4. More general economic shocks

Thus far we have focused on shocks of a political economy kind, that is shocks affecting Foreign welfare only through Home’s tariff \(t\). We now extend the analysis to the case of more general economic shocks, allowing \(\lambda\) to affect Foreign welfare not just through the policy but also directly; conventional demand or supply shocks in Home and/or in Foreign in general will have this feature.

\(^{27}\)One can also ask how the optimal MPA affects trade volatility. It is easy to show that in the “neutral” case of constant export supply elasticity, an MPA that reduces policy uncertainty also reduces trade volatility. Thus there is a tendency for the optimal MPA to impact policy uncertainty and trade (volume and value) uncertainty in the same direction. But if the export supply elasticity is not constant, the impact of a change in policy uncertainty on trade volatility is ambiguous.

\(^{28}\)We can provide an approximate measure of the impact of the MPA on expected trade, along similar lines as the approximation of the welfare gains from an MPA that we derived in section 3.1. Considering a small mean-preserving spread of the Nash tariff of the form \(t^N(\lambda) + \delta(\lambda - \bar{\lambda})\), as we did above, and evaluating its effect around the Nash equilibrium, we find \[
\frac{\partial E \ln x^*}{\partial \delta} \bigg|_{\delta=0} \approx \frac{\partial \pi^*}{\partial \pi^*} \cdot \varepsilon_{\pi}^* \cdot \sigma_{\lambda}^2.
\]
Finally, one can show that the approximate relative impact of an MPA versus a UPA on expected (log) trade is given by
\[
\frac{\frac{\partial E \ln x^*}{\partial \theta} \bigg|_{\theta=0}}{\frac{\partial E \ln x^*}{\partial \alpha} \bigg|_{\alpha=0}} \approx \frac{\partial \ln \varepsilon_x^*}{\partial \pi^*} \cdot \varepsilon_{\pi}^* \cdot \sigma_{\lambda}^2.
\]
To apply the condition derived in the reduced-form analysis of section 2, start by recalling that Foreign’s terms of trade are given (in logarithmic form) by $\pi^*(t, \lambda) = \pi(\lambda) - t$. This notation emphasizes that the shock may affect Foreign’s terms of trade, holding the policy $t$ constant, through Home’s domestic price; this will be the case if the domestic shock affects economic conditions at Home. In addition to affecting Foreign welfare through the terms-of-trade channel just highlighted, the shock may affect Foreign welfare directly (that is, holding TOT constant); this will be the case for example if $\lambda$ represents a global demand or supply shock. To emphasize the two distinct channels through which $\lambda$ can affect Foreign welfare for given policy $t$, we start by writing Foreign’s welfare in reduced form as a function of the terms of trade and the shock as $V^*(t; \lambda) = V^*(\pi(\lambda) - t, \lambda)$. Recalling that the Foreign government maximizes national welfare, we can write $G^*(t, \lambda) = V^*(\pi(\lambda) - t, \lambda)$.

Recall from section 2 that there is an uncertainty-reducing motive for a TA if $G^*_{\lambda t} + G^*_{\lambda t} < 0$, and recall our interpretation of the term $G^*_{\lambda t} \cdot \varepsilon^*_\lambda$ as capturing the effect of policy-risk preference, while we interpreted the term $G^*_{\lambda t}$ as capturing a policy-externality-shifting effect.

Using $G^*_{t N} = v^*\Omega^*$, plugging in the expression (3.2) for $G^*_{t N}$ and simplifying, we find that there is an uncertainty-reducing motive for a TA if

\[
(\theta \Omega^* + \varepsilon^*_x + D^*) \varepsilon^*_\lambda - \varepsilon^*_\lambda \frac{\partial \ln (v^*\Omega^*)}{\partial \lambda} < 0,
\]

where $\frac{\partial \ln (v^*\Omega^*)}{\partial \lambda}$ denotes the elasticity of adjusted openness with respect to the shock holding $p^*$ constant, $\varepsilon^*_\lambda \equiv \pi'(\lambda)$ is the elasticity of Home’s domestic price with respect to the shock, and the left hand side of (4.1) is evaluated at the noncooperative tariff.

To interpret (4.1), start by recalling that the sign of Foreign’s preference for trade policy risk is given by the sign of $(\theta \Omega^* + \varepsilon^*_x + D^*)$. Thus the term $(\theta \Omega^* + \varepsilon^*_x + D^*) \varepsilon^*_\lambda$ in (4.1) is related to the policy-risk preference effect. This term is analogous to the case of political-economy shocks considered in the previous section.

The new feature with more general shocks is the presence of a policy-externality-shifting effect. This effect operates through two possible channels. Recall that Foreign welfare can be written as $V^*(\pi(\lambda) - t, \lambda)$, and recall our discussion above of the two possible channels through which $\lambda$ can affect $V^*$ holding $t$ constant. Similarly, $\lambda$ can affect the marginal policy externality ($V^*_t$) through two possible channels: the term $(\theta \Omega^* + \varepsilon^*_x + D^*) \varepsilon^*_\lambda$ in (4.1) captures the impact of $\lambda$ on the policy externality through Home’s domestic price $\pi$, and the term $\frac{\partial \ln (v^*\Omega^*)}{\partial \lambda}$ captures the direct impact of $\lambda$ on the policy externality holding terms of trade $\pi^*$ constant.
Note that, if the shock $\lambda$ is *importer specific*, in the sense that it originates in the Home country and affects Foreign welfare only through the terms of trade $\pi^*$, only the first of the two channels highlighted above is operative, so $\frac{\partial \ln (\nu^* \Omega^*)}{\partial \lambda} = 0$ and condition (4.1) boils down to $(\theta \Omega^* + \varepsilon_+^* + D^*) (\varepsilon_+^* - \varepsilon_+^*) < 0$. To highlight the implications of this type of shock, suppose to fix ideas that Foreign is averse to terms-of-trade risk (or equivalently to trade-policy risk), that is $\theta \Omega^* + \varepsilon_+^* + D^* < 0$. Note that the total impact of $\lambda$ on TOT is given by $\frac{d \pi^*}{d \lambda} = \varepsilon_+^* - \varepsilon_+^*$, so there are two different sources of TOT risk: a “policy” risk (captured by $\varepsilon_+^*$) and an “economic” risk (captured by $\varepsilon_+^*$). Without economic risk (e.g. in the case of a pure political-economy shock), a mean preserving compression in $t$ clearly reduces TOT risk. And the same is true whenever policy risk is not offset by economic risk, so that $\frac{d \pi^*}{d \lambda} < 0$. But if the economic risk offsets the policy risk ($\varepsilon_+^*$ is positive and dominates $\varepsilon_+^*$), then TOT risk is reduced by increasing policy risk, so in this case the optimal MPA will increase policy risk.\(^{29}\)

Next focus on the case in which the shock $\lambda$ is *global*, in the sense that it affects domestic conditions in both countries (or equivalently, suppose that the two countries experience perfectly correlated domestic shocks). In this case both channels of the policy-externality-shifting effect that we described above will be operative. The second effect (through $\frac{\partial \ln (\nu^* \Omega^*)}{\partial \lambda}$) can be interpreted as follows: if shocks that increase the noncooperative tariff also increase the adjusted degree of openness for a fixed tariff, this strengthens the uncertainty-reducing motive.

It is worth emphasizing that, unlike in the case of political-economy shocks considered in the previous section, here the impact of the optimal MPA on trade-policy uncertainty is not determined solely by Foreign’s preference for trade-policy risk. One implication is that it is possible that even if individuals are risk-neutral ($\theta \to 0$) and hence the Foreign country is policy-risk loving ($\theta \Omega^* + \varepsilon_+^* + D^* > 0$), there may be an uncertainty-reducing motive for a TA.

The sign of the externality-shifting effect in general depends on the exact nature of the shock and of the economic structure, but we now highlight an interesting case in which the externality-shifting effect indeed pushes towards an uncertainty-reducing motive. Suppose that $\lambda$ is a shock to foreign export productivity that strengthens comparative advantage, so that

\[^{29}\text{In the case of importer-specific shocks we can show a further result: under a regularity condition, the optimal MPA reduces terms-of-trade risk if Foreign is averse to terms-of-trade risk (or equivalently to trade-policy risk), that is if } \theta \Omega^* + \varepsilon_+^* + D^* < 0. \text{ The regularity assumption we need is the following: if we define Home’s choice variable as } \pi^* \text{ rather than } t \text{ (which is clearly equivalent), we need Home’s noncooperative choice of } \pi^* \text{ to be monotonic in } \lambda, \text{ which is ensured if } \frac{d^2 G}{d \pi^* d \lambda} \text{ does not change sign over the relevant range of } (\pi^*, \lambda). \text{ Thus, in the case of importer-specific shocks, the impact of the optimal MPA on TOT risk is determined solely by the Foreign country’s preference for TOT/policy risk, and follows the same intuitive pattern as in the case of political economy shocks.}\]
Foreign’s openness $\Omega^*$ is higher (for given TOT) when $\lambda$ is higher. Further suppose that Home’s noncooperative tariff $t^N$ increases with trade volume; this is compatible with our model if TOT manipulation motives are important for Home’s choice of tariff. In this case $t^N$ is increasing in $\lambda$, as assumed in our model. Then, if the effect of the shock via $v^*\theta$ is not too strong, the sign of $\frac{\partial (v^*\Omega^*)}{\partial \lambda}$ will be positive, thus contributing towards an uncertainty-reducing motive.

4.1. A sufficient statistic for the uncertainty motive

Expression 4.1 is useful because it highlights the key effects that determine the uncertainty motive for a TA. If one is willing to assume that the model is true, one can in principle take this condition to the data to check if there is an uncertainty motive for a TA. However, in practice this would require considerable information, including information about the exact nature of the shock and about the various elasticities involved. In what follows we provide an alternative condition that can be used to answer this question without information about the nature of the shock, and in a way that is relatively simple to implement empirically.

As we observed above, an uncertainty-reducing motive for a TA requires $\frac{d}{d\lambda}(-v^*\theta\Omega^*)^N < 0$. Recalling that $t^N(\lambda)$ is increasing, letting $\lambda(t^N)$ denote its inverse, and noting that $d\lambda = dt^N/t^N(\lambda)$, the condition can be rewritten as

$$\frac{d}{dt^N} \ln(v^*\theta\Omega^*) > 0$$

We can interpret this expression as an induced elasticity, that is the elasticity of $(v^*\theta\Omega^*)^N$ with respect to the tariff (recall $t^N$ is the log of the tariff factor) induced by the variation in the underlying shock. In principle, one can use information on openness, real income per capita ($v^*$) and estimates of $\theta$ to construct a measure of the adjusted degree of openness. The analysis above then implies that if this measure is positively correlated with noncooperative tariffs there is an uncertainty reducing motive for a TA. We record this in the following remark

**Remark 3.** There is an uncertainty-reducing motive for a TA if and only if, at the noncooperative equilibrium, the adjusted degree of openness $v^*\theta\Omega^*$ is positively correlated with the tariff.

We now illustrate with a concrete example how this sufficient statistic approach can be used to check the direction of the uncertainty motive for a TA. Recall that this sufficient statistic
can be constructed without information about the exact source of the shocks, and requires only
data on non-cooperative tariffs and adjusted openness.

Our model is static in nature, but it seems natural to use the time variation in noncooperative
tariffs and adjusted openness to measure their correlation. We focus on the annual US average
tariff prior to 1934, the year of the Reciprocal trade agreement act (RTAA), which “ended” the
Smoot Hawley era and started a period of more cooperative trade policies (Irwin, 1998). More
specifically, we use \( t = \ln(1 + \tau) \), where \( \tau \) is the US import-weighted average tariff starting
in 1867. We start by plotting the time series of the US average tariff from 1867 to 1934. See
Figure 2. Note that there is considerable variation in the average tariff in the non-cooperative
period. Part of this variation is simply a downward trend,\(^{30}\) but note that there is a considerable
amount of variation around the trend.

The first agreement that the US signed under the RTAA was with Cuba in 1934. This,
together with the fact that Cuba was a small open country (its export share of GDP was on
average 0.32) with a considerable amount of trade with the US, makes the US-Cuba pair a
good fit to illustrate how our correlation test can be performed. We use data available for Cuba
on openness and income per capita in the period 1903-1933 to calculate a measure of adjusted
openness at alternative levels of risk aversion.

As a preliminary exercise, in Figure 3 we plot adjusted openness, \( \ln(\nu^\theta \Omega^*) \big|_{\theta=5} \) against \( t \).\(^{31}\) The figure shows a strong positive correlation. Table 1 goes one step further and provides
alternative measures of correlation between these two variables for a range of risk aversion
levels. We note two points. First, the correlation is negative if there is no risk aversion (first
row). Second, if the risk aversion is sufficiently high (-2 to -10) the correlation is positive. This
result is independent of whether we use \( t \) or its detrended value. Moreover, we find the same
result using a rank correlation measure, which shows that the association is not only positive
but also significantly different from zero when risk aversion is strong enough.

In sum, this section illustrates how the model can be used to check whether there is a
policy-uncertainty reducing motive for a TA between two countries. The positive correlation
between US tariffs and Cuban adjusted openness suggests that this was indeed the case for these
countries in the period before their 1934 agreement. It is important to emphasize, however,

\(^{30}\)This trend is probably due to the fact that the revenue motives for imposing tariffs (which were arguably
important before the civil war) declined over time for various reasons, including the introduction of the income
tax in 1916.

\(^{31}\)We detrend the ln tariff factor by removing its linear time trend.
that this exercise is not a test of the model, but rather it assumes the model is true and so it must be taken with a grain of caution, since the model is very stylized. The message we want to convey is that it is feasible to take our model to the data in a meaningful way, and it might be desirable to develop richer and more realistic versions of our model in order to quantify the uncertainty-related gains from TAs.

5. Uncertainty and trade agreements with ex-ante investments

Thus far we have assumed that allocation decisions occur ex post, after the shock is realized. But in reality there are a variety of production factors that cannot be flexibly shifted in response to policy and economic shocks. In this section we consider the implications of allowing for allocation decisions that must be made ex-ante, before the shock is realized, or “ex-ante investments”. As we noted in the introduction, the often-heard informal arguments about the motives for TAs claim that they should increase investment and trade by reducing uncertainty. Allowing for ex-ante investments in our model seems compelling if one wants to formally examine this issue.

We start from our basic model of section 3 with political-economy shocks and extend it to allow for ex-ante investments.

Recall that the model allows for an arbitrary number of factors that are mobile ex-post. We now assume that one of these, “capital,” is mobile ex-ante but fixed ex-post. We normalize the endowment of capital to one and let $k^*$ denote the fraction of capital allocated to the export sector. To simplify the analysis we assume that all factors in the Home country are perfectly flexible so they can be allocated after the shock $\lambda$ is realized. This allows us to keep the economic structure for Home in the background, as we did in the static model.

We assume the following timing: (1) A tariff schedule is selected (cooperatively or noncooperatively); (2) capital is allocated; (3) $\lambda$ is realized; (4) the trade policy is implemented and markets clear.

In the noncooperative scenario, we let the Home country choose a contingent schedule $t^N(\lambda)$ to maximize its expected payoff. In the cooperative scenario, again we let countries choose a schedule $t^{MPA}(\lambda)$ to maximize expected joint welfare subject to the constraint $Et^{MPA}(\lambda) =$

\[32\] We could allow for a higher number of factors that are mobile ex ante but fixed ex post, but the notation would get more cumbersome. And of course, the model also allows for factors that are fully fixed (immobile both ex ante and ex post).
EtN (λ). Thus we keep the timing constant across the cooperative and noncooperative scenarios. The reason for this choice is to abstract from domestic-commitment motives for TAs. And of course, if we want a TA to be able to affect investment decisions by managing policy uncertainty, we need to assume that policy choices come before investment decisions, and this explains our choice of timing. 33

The first step of the analysis is to extend Proposition 1 from the previous static setting to the present dynamic environment. Since capital is allocated after observing the trade policy schedule, and the allocation may depend on whether or not an agreement is in place, we write Foreign’s objective as \( G^*(t(\lambda), k^*) \). We continue to write Home’s objective as \( G(t(\lambda), \lambda) \), which reflects the small country assumption. 34

In keeping with our assumption that there is no role for trade policy intervention in Foreign, assume that capital is perfectly divisible, so that the citizens of the small country are not only identical ex-ante, but also ex-post, and thus there is no redistribution motive for a tariff. Moreover, if Foreign maximizes the representative agent’s welfare then capital in Foreign is efficiently allocated given Home’s trade policy, that is, \( k^* \) also maximizes \( EG^*(t(\lambda), k^*) \).

We now argue that Proposition 1 extends to this setting, in the sense that we only need to determine the sign of \( dG^*_t(tN(\lambda), k^*)/d\lambda \) to know if there is an uncertainty-reducing role for a TA. The following local argument provides some intuition for the result. Starting at \( tN(\lambda) \), a small mean-preserving compression has no first order effect on \( G \) since this objective is maximized by \( tN(\lambda) \). Therefore, the new schedule will only increase \( EG^W \) if it increases \( EG^* \). This policy change will have no first-order effect on \( EG^* \) via \( k^* \) because \( k^* \) is socially efficient given the policy schedule. So any impact of the policy change on \( EG^* \) must be due to the “static” effect, i.e. to \( G^*_{ttN} < 0 \).

We now consider the full MPA program. Recalling that, for a given \( t(\lambda) \), the level of \( k^* \) maximizes \( EG^*(t(\lambda), k^*) \) and has no effect on \( EG \), then \( k^* \) maximizes \( EG^W(t(\lambda), \lambda; k^*) \).

33While the assumption is made to provide a clean thought experiment, we note that in some cases countries are able to choose contingent protection programs in ways that represent long-term commitments. For example the U.S. and the E.U. have contingent protection laws that apply in the absence of trade agreements.

34Suppose for example the Home country maximizes the welfare of a representative individual (a similar argument would apply if Home maximized some weighted average of individuals’ indirect utilities, reflecting political economy concerns): \( G = G(v(\pi, y, \lambda)) \). The indirect utility \( v \) is a function of the domestic relative price \( \pi \) and income, with income itself a function of \( \pi \), Home endowments and tariff revenue. Tariff revenue is in turn a function of \( t \) and trade volume, where the latter is again function of \( \pi \). So we can write \( G(v(\pi, t, \lambda)) \), and if the Foreign country is small then \( \pi \) is independent of \( t \) and Foreign endowments, so we can simply write \( G(t, \lambda) \).
we can write the MPA program as

$$\begin{align*}
\max_{t(\lambda), k^*} & \quad EG^W(t(\lambda), \lambda, k^*) \\
\text{s.t.} & \quad Et(\lambda) = Et^N(\lambda)
\end{align*}$$

(5.1)

Assuming an interior optimum, we obtain the following FOCs:

$$G^W_t(t, \lambda, k^*) = \psi \quad \text{for all } \lambda$$

(5.2)

$$Et(\lambda) = Et^N(\lambda)$$

$$EG^W_{k^*}(t(\lambda), \lambda, k^*) = 0$$

(5.3)

We can now apply a similar argument as in the static model, using the first two of the FOC above. The only difference is that the derivative $\frac{d}{dk} G^*_{t} N$ is evaluated at the optimal level of $k^*$, but as long as the sign of this derivative does not change with $k^*$, Proposition 1 extends. In Appendix we prove the following:

**Proposition 4.** (a) If $G^*_{tt}(t^N(\lambda), k^*) < 0$ ($> 0$) for all $(k^*, \lambda)$, then there is an uncertainty-reducing (-increasing) motive for a TA. (b) If $G^*_{tt}(t^N(\lambda), k^*) = 0$ for all $(k^*, \lambda)$, then there is no uncertainty motive for a TA.

Proposition 4 highlights that the uncertainty motive for the TA is driven by the static effect, i.e. the impact of the shock on the policy externality conditional on the capital level. In a broad sense, we can interpret this result as indicating that there is no separate “investment motive” in the context of a TA that addresses policy uncertainty.

This conclusion, as we highlighted, relies on the competitive allocation of capital being socially efficient given the importer’s trade policy, which is ensured in our setting by the assumptions of welfare maximizing government and perfectly divisible capital. While these assumptions are somewhat restrictive, we note that the same result would obtain in a setting where capital is not divisible, provided the government can use an entry subsidy/tax to effectively control the allocation of capital.\footnote{To see this note that whether the competitive allocation is efficient or not depends crucially on whether capital is divisible or indivisible. If capital is divisible, all citizens will have identical incomes ex-post, and as a consequence, there is no idiosyncratic risk, hence no scope for insurance markets, which implies the competitive allocation is efficient. There is aggregate risk in this economy, but it cannot be diversified away (since we are not considering international insurance markets). If capital is indivisible, so that each citizen must choose ex-ante} Of course one could consider reasonable alternative scenarios where capital allocation is not efficient, and in such scenarios there could be an “investment motive”
for an uncertainty-managing TA, or in other words, there could be scope for a TA to “correct” the capital allocation through changes in policy uncertainty, but it is important to keep in mind that this would be a second-best argument for such TAs, as the first-best way to address such inefficiency would be the use of more targeted policies.

Given that the condition for an uncertainty-reducing motive for a TA is similar to the static model, the results of the previous sections apply as stated, with the only difference that the relevant expressions are evaluated at a given capital allocation. Moreover, the expressions for the approximate values of an MPA and a UPA are also unchanged, since there is no first order effect on Foreign welfare due to capital re-allocation. But even if there is no separate “investment” motive for a MPA, such an agreement in general does affect equilibrium investment and trade levels relative to the noncooperative equilibrium, as we show next.

5.1. Investment and trade effects of the MPA

We start by asking how the optimal MPA affects ex-ante investments. We focus on the case in which Foreign is policy-risk averse ($G_{tt} < 0$), so that the optimal MPA reduces policy risk. To simplify the exposition we also assume that the trade pattern does not switch as $k^*$ changes, that is, Foreign exports the nonnumeraire good for all $k^* \geq 0$.

Recall that efficient capital allocation implies $\frac{\partial E G^* (t, k^*)}{\partial k^*} = 0$. By standard results (Rotschild and Stiglitz, 1971), the equilibrium $k^*$ increases as a result of a mean-preserving compression in $t$ if $\frac{\partial}{\partial k^*} G_{tt}^* (t, k^*) < 0$ for all $t$ in its support. Thus the effect depends on the impact of $k^*$ on Foreign’s policy risk preference. In general this effect can go in either direction, but we now highlight interesting sufficient conditions under which it is negative. We will show that this is the case if uncertainty is sufficiently small, in the sense that the support of $\lambda$ is small, and risk aversion sufficiently strong.\(^{36}\)

\(^{36}\)The general ambiguity of the impact of mean-preserving changes in prices on investment decisions is well known. In the literature this ambiguity is resolved in different ways, e.g. assuming decreasing absolute risk aversion, positing a specific shock distribution, restricting the economic environment or, as we do, considering cases with small uncertainty. But we emphasize that our result is novel: we are not aware of any existing result that expresses a similar set of sufficient conditions for a similar economic environment. We also note that we
Note that the result of Proposition 3 extends directly to this dynamic setting, in the sense that the expression for $G_{tt}$ is just the same as in (3.2), provided its various components are re-interpreted as conditional on the capital allocation $k^*$. Subject to this re-interpretation, we have

$$
\frac{\partial}{\partial k^*} G_{tt}^* (t, k^*) = \frac{\partial}{\partial k^*} \left[ v^* \theta \Omega^* (\theta \Omega^* + \varepsilon_x^* + D^*) \right]
$$

(5.4)

In Appendix we prove that, if $\theta$ is sufficiently negative and the support of $\lambda$ sufficiently small, then $\frac{\partial}{\partial k^*} G_{tt}^* (t, k^*) < 0$ for all $t$ in its support, which leads to the following:

**Proposition 5.** If there is sufficient income risk aversion and the support of $\lambda$ is sufficiently small, then the optimal MPA increases investment in the export sector.

Broadly interpreted, this proposition suggests that under the condition that generates an uncertainty-reducing motive for a TA, namely a strong degree of income-risk aversion, the agreement leads to higher investment in the export sector, provided the underlying uncertainty in the environment is small enough. We also note that the same result would hold if we replaced the condition that $\theta$ is sufficiently negative with the alternative condition that the export supply elasticity $\varepsilon_x^*$ is sufficiently close to constant, as we show in Appendix.

Finally we re-examine the impact of the optimal MPA on expected trade volume in the presence of ex-ante investments.

Recall first that, in the absence of ex-ante investment, if the MPA reduces policy uncertainty, expected trade increases if and only if the export supply elasticity $\varepsilon_x^* (\pi^*)$ is decreasing in $\pi^*$. In the presence of ex-ante investment, we can write trade volume as $x^* (\pi^*, k^*)$, thus the MPA increases expected log trade if and only if the following is positive

$$
\int \ln x^* (\pi^*, k^{*MPA}) dF_{MPA}^k (\pi^*) - \int \ln x^* (\pi^*, k^{*N}) dF_{N}^k (\pi^*)
\]

$$
= \int \ln x^* (\pi^*, k^{*N}) d \left( F_{MPA}^k (\pi^*) - F_{N}^k (\pi^*) \right) + \int \ln \frac{x^* (\pi^*, k^{*MPA})}{x^* (\pi^*, k^{*N})} dF_{MPA}^k (\pi^*)
$$

where $k^{*MPA}$ and $k^{*N}$ are respectively the equilibrium capital levels at the optimal MPA and at the Nash equilibrium, and $F_{N}^k$ and $F_{MPA}^k$ are the respective distributions of $\pi^*$. The first term in the expression above is analogous to the one in the static model, so it depends on whether could prove the result under the alternative assumption that the probability mass is sufficiently concentrated, rather than the support being sufficiently small, but in this case the notation and the analysis would be more cumbersome.
\[
\varepsilon^*_x (\pi^*, k^{*N}) \equiv \partial \ln x^* (\pi^*, k^{*N}) / \partial \pi^* \text{ is increasing or decreasing in } \pi^*. \text{ The second term captures the expected growth in exports due to the change in investment. If } k^* \text{ increases, this effect will be positive if the support of the shock is sufficiently small and the economy is not completely specialized.}^{37}
\]

Summarizing, if risk aversion is sufficiently strong and uncertainty is sufficiently small, the optimal MPA reduces uncertainty in trade policy and increases investment in the export sector. Moreover, under these conditions, expected trade increases provided the export supply elasticity does not increase too rapidly with TOT.\(^{38}\)

### 6. Two policy-active countries

In this section we extend our basic model by allowing for two policy-active countries. We focus on the reduced-form framework of section 2 and abstract from ex-ante investments for simplicity.

We represent the reduced-form payoff functions as \(G(t, t^*, \lambda)\) and \(G^*(t^*, t, \lambda^*)\). The central difference relative to the small-large country setting is the presence of two policy dimensions. For tractability, we assume that countries are mirror-image symmetric. And we continue to assume a single dimension of uncertainty, or \(\lambda^* = \lambda\); the interpretation is that there is a global shock that affects symmetrically the two countries, or equivalently, two domestic shocks that are perfectly correlated.

Given symmetry, we define the common payoff given a common tariff \(t\) as \(\tilde{G}(t, \lambda) \equiv G(t, t, \lambda)\).

We make the following assumptions:

(i) Single crossing properties: \(\tilde{G}_{t\lambda} > 0, G_{t\lambda} > 0\) (and by symmetry, \(G^*_{t^*\lambda} > 0\));

(ii) Concavity: \(\tilde{G}\) concave in \(t\), \(G\) concave in \(t\) (and by symmetry, \(G^*\) concave in \(t^*\));

(iii) Stability of reaction functions: \(|G_{tt}| > G^*_{tt^*}\) (and analogously for Foreign).

Given that countries are symmetric, the Nash equilibrium tariffs are symmetric, and implic-
nly defined by the following FOC:

\[ G_t(t^N, t^N, \lambda) = 0. \]

This condition yields the Nash equilibrium tariff schedule \( t^N(\lambda) \). Given our assumptions, \( t^N(\lambda) \) is increasing, as can be verified by implicitly differentiating the FOC:

\[
\frac{dt^N}{d\lambda} = \frac{G_{t\lambda}^N}{-(G_{tt}^N + G_{t\lambda}^N)} > 0
\]

where the numerator is positive by the single crossing property and the denominator is positive by the stability assumption.

Given the symmetry of the problem, it is reasonable to focus on the optimal symmetric MPA, which is given by:

\[
t^{MPA}(\lambda) = \arg \max_{t(\lambda)} E\tilde{G}(t(\lambda), \lambda) \text{ s.t. } Et(\lambda) = Et^N(\lambda). (6.1)\]

We can write the Lagrangian for this problem as

\[
L = \int [\tilde{G}(t, \lambda) + \psi t^N(\lambda) - \psi t(\lambda)] dF_{\lambda}(\lambda) \quad (6.2)
\]

Maximizing this Lagrangian pointwise yields the FOCs

\[
\tilde{G}_t(t(\lambda), \lambda) = \psi \text{ for all } \lambda
\]

\[
Et(\lambda) = Et^N(\lambda)
\]

We can prove the following:

**Proposition 6.** If \((G_{tt}^{*N} + G_{tt}^{*N}) \cdot \frac{dt^N}{d\lambda} + G_{t\lambda}^{*N} < 0 \) for all \( \lambda \) then there is an uncertainty reducing (increasing) motive for a TA. If \((G_{tt}^{*N} + G_{tt}^{*N}) \cdot \frac{dt^N}{d\lambda} + G_{t\lambda}^{*N} = 0 \) for all \( \lambda \) then there is no uncertainty motive for a TA.

We can now contrast the result of Proposition 6 with the corresponding result for the small-large country setting. The general condition for a policy uncertainty reducing motive, \ \( \frac{d}{d\lambda} G_{t}^{*N} < 0 \), is similar to the small-large setting, but in the large-large country setting this expression includes an additional term, namely \( G_{t\lambda}^{*N} \). We label this the “strategic interaction”

---

\[ {39} \text{Given the concavity of the payoff functions, we conjecture that the global maximum is indeed symmetric, so that there is no loss of generality in focusing on a symmetric MPA.} \]
effect, which is positive if tariffs are strategic complements and negative if they are strategic substitutes. Thus an interesting new insight that emerges is that the strategic-interaction effect works in favor of the uncertainty reducing motive if tariffs are strategic substitutes, and vice-versa if tariffs are strategic complements. Whether tariffs are strategic substitutes or complements depends on the specifics of the trade structure (see for example Syropoulos, 2002), so the direction of this effect is ultimately an empirical question.

Note also that while the other terms are similar, they will reflect additional effects. In particular, the attitude towards foreign policy risk $G^*_{tt}$ and the externality-shifting effect $G^*_{t\lambda}$ will now include tariff-revenue and pass-through elasticity effects that were absent in the small-large country setting.

One important remark concerns the externality-shifting effect $G^*_{t\lambda}$. As we explained in a previous section, this term effectively disappears if the shocks are importer-specific. But with two large symmetric countries, the shock will always directly affect both countries and hence this term cannot disappear. This implies that even if countries are TOT-risk neutral there will generically be an uncertainty motive for a TA.

Finally, we can show that the expressions derived in section ??, which approximate the gains from managing policy risk and policy mean relative to the noncooperative outcome (and the relative importance of the two motives) are still valid as stated in this symmetric-country setting.

7. Conclusion

In this paper we examine by means of formal economic analysis the often-heard informal argument that a trade agreement can provide gains to its member countries by decreasing uncertainty in trade policies, in addition to the more standard gains from reducing the mean levels of trade barriers. We start by showing that, in a standard trade model with income-risk neutrality, there tends to be an uncertainty-\textit{increasing} motive for a TA. With income-risk aversion, on the other hand, an uncertainty-reducing motive for a TA may emerge. In particular, we find that for a given degree of risk aversion an uncertainty-reducing motive for a TA is more likely to be present when the economy is more open, the export supply elasticity is lower and the economy is more specialized. The model suggests that, as the world becomes more integrated, the gains from decreasing trade-policy uncertainty should grow, both in absolute terms and relative to
the gains from managing mean policy levels. We find that, when the trading environment is more uncertain, governments have more to gain by joining a TA. We develop a simple “sufficient statistic” to determine whether there is an uncertainty-reducing motive for a TA, and illustrate how it can be taken to the data, by focusing on the bilateral trading relationship between the US and Cuba before their agreement in 1934. Finally, we examine conditions under which an uncertainty-reducing TA will increase investment in the export sector and raise expected trade volume.

There are several potentially interesting avenues for future research. Here we mention two of them. We think it would be interesting to examine the role of uncertainty-reducing trade agreements in settings where the underlying reason for the agreement is not the classic TOT externality: in particular, one might consider settings in which agreements are motivated by the governments’ need for domestic commitment, or by the presence of non-TOT international externalities. Also, a challenging but potentially fruitful direction of research would be to develop a richer version of our model with the objective of taking it to the data: this would probably require, among other things, allowing for multiple countries, multiple goods and imperfectly correlated shocks across countries.

References


8. Appendix

Proof of Lemma 1:

We start by proving part (ii). The schedules $t^{MPA}(\lambda)$ and $t^{N}(\lambda)$ are clearly continuous. The mean constraint and the continuity of $t^{MPA}(\lambda)$ and $t^{N}(\lambda)$ ensure the existence of at least one intersection. Consider one such intersection $\hat{\lambda}$, so that $t^{MPA}(\hat{\lambda}) = t^{N}(\hat{\lambda})$. By the FOC, $G_{t}^{W}(t^{N}(\hat{\lambda}), \hat{\lambda}) = \psi$. Since $G_{t}(t^{N}(\hat{\lambda}), \hat{\lambda}) = 0$ this implies $G_{t}^{*}(t^{N}(\hat{\lambda}), \hat{\lambda}) = \psi$. Now if $\frac{d}{d\lambda}G_{t}^{*}(t^{N}(\lambda), \lambda) = 0$ then $G_{t}^{*}(t^{N}(\lambda), \lambda) = \psi$ for all $\lambda$, which in turn implies $G_{t}^{W}(t^{N}(\lambda), \lambda) = \psi$ for all $\lambda$. Therefore the schedule $t^{N}(\lambda)$ satisfies the FOC, hence $t^{MPA}(\lambda) = t^{N}(\lambda)$ for all $\lambda$.

We next prove part (i), focusing on the case $\frac{d}{d\lambda}G_{t}^{*}(t^{N}(\lambda), \lambda) < 0$. Again, $t^{MPA}(\lambda)$ and $t^{N}(\lambda)$ must intersect at least once. We now argue that $t^{MPA}(\lambda)$ can only intersect $t^{N}(\lambda)$ from above.

This, together with continuity, will also ensure the uniqueness of the intersection.

We argue by contradiction. Suppose $t^{MPA}(\lambda)$ intersects $t^{N}(\lambda)$ at some point $\hat{\lambda}$ from below. Consider two values of $\lambda$ on the opposite sides of this intersection, $\lambda_{1} < \hat{\lambda} < \lambda_{2}$, such that $t^{MPA}(\lambda_{1}) < t^{N}(\lambda_{1})$ and $t^{MPA}(\lambda_{2}) > t^{N}(\lambda_{2})$.

Recalling that $G_{t}(t^{N}(\lambda), \lambda) = 0$ and $\frac{d}{d\lambda}G_{t}^{*}(t^{N}(\lambda), \lambda) < 0$ for all $\lambda$, then

$$G_{t}^{W}(t^{N}(\lambda_{2}), \lambda_{2}) = G_{t}^{*}(t^{N}(\lambda_{2}), \lambda_{2}) < G_{t}^{*}(t^{N}(\lambda_{1}), \lambda_{1}) = G_{t}^{W}(t^{N}(\lambda_{1}), \lambda_{1})$$

These inequalities and the concavity of $G_{t}^{W}$ in $t$ imply

$$G_{t}^{W}(t^{MPA}(\lambda_{2}), \lambda_{2}) < G_{t}^{W}(t^{N}(\lambda_{2}), \lambda_{2}) < G_{t}^{W}(t^{N}(\lambda_{1}), \lambda_{1}) < G_{t}^{W}(t^{MPA}(\lambda_{1}), \lambda_{1})$$

This contradicts the FOC, which requires $G_{t}^{W}$ to be equalized across states. QED

Proof of Proposition 1:

First observe that $G_{t\lambda} > 0$ implies $t^{N}(\lambda)$ is increasing, and $G_{t\lambda}^{W} > 0$ implies $t^{MPA}(\lambda)$ is increasing (this can be proved by implicitly differentiating the FOC for the MPA problem and recalling that $\psi$ is independent of $\lambda$).

Part (i). Focus on the case $\frac{d}{d\lambda}G_{t}^{*}(t^{N}(\lambda), \lambda) < 0$. By Lemma 1, in this case $t^{MPA}(\lambda)$ intersects $t^{N}(\lambda)$ once and from above. We show that the random variable $t^{N}(\lambda)$ is a second order stochastic shift of the random variable $t^{MPA}(\lambda)$, which together with the fact that these two random variables have the same mean implies that the former is a MPS of the latter. Let $\lambda^{N}(t)$ denote the inverse of $t^{N}(\lambda)$ and $\lambda^{MPA}(t)$ the inverse of $t^{MPA}(\lambda)$; these inverse functions exist because
t^N(\lambda) and t^{MPA}(\lambda) are both increasing. Also, let \hat{t} be the value of t for which the two curves intersect.

The cdf of \(t^N\) is given by \(F_N(t) = Pr(t^N(\lambda) \leq t) = Pr(\lambda \leq \lambda^N(t))\) and the cdf of \(t^{MPA}\) is given by \(F_{MPA}(t) = Pr(t^{MPA}(\lambda) \leq t) = Pr(\lambda \leq \lambda^{MPA}(t))\). Lemma 1 implies that \(\lambda^{MPA}(t) < \lambda^N(t)\) for all \(t < \hat{t}\) and \(\lambda^{MPA}(t) > \lambda^N(t)\) for all \(t > \hat{t}\), which in turn implies that \(F_{MPA}(t) < F_N(t)\) for all \(t < \hat{t}\) and \(F_{MPA}(t) > F_N(t)\) for all \(t > \hat{t}\). This implies that \(t^N(\lambda)\) is a second order stochastic shift of \(t^{MPA}(\lambda)\), as claimed.

Part (ii) was already proved in Lemma 1. QED

**Proof of Proposition 2:**

Start by noting that \(G^*_t = \frac{\partial^2 G^*}{\partial (\ln p)^2}\). It is straightforward to derive:

\[
\frac{\partial^2 G^*}{\partial (\ln p)^2} = \left(\ln v^* \right)^2 \left( \frac{\partial \ln v^*}{\partial \ln p^*} \right)^2 + \left( \frac{\partial \ln v^*}{\partial \ln p^*} \right) \frac{\partial^2 \ln v^*}{\partial (\ln p^*)^2},
\]

where \(\ln v^* = \ln R^* - \ln \phi^*\). Next note that \(\frac{\ln R^*}{\ln p^*} = \frac{p^* q^*}{R^*}\). Differentiating this elasticity with respect to \(\ln p^*\) and simplifying, we obtain:

\[
\frac{\partial^2 \ln R^*}{\partial (\ln p^*)^2} = \frac{p^* q^*}{R^*} \cdot (1 - \frac{p^* q^*}{R^*}) + \frac{p^* q^*}{R^*}.
\]

Next note that employing Roy’s identity we obtain \(c^* = \frac{\phi^* R^*}{p^*}\), hence \(\frac{\partial \ln \phi^*}{\partial \ln p^*} = \frac{p^* c^*}{R^*}\). It follows that

\[
\frac{\partial^2 \ln \phi^*}{\partial (\ln p^*)^2} = \frac{\partial \left( \frac{p^* c^*}{R^*} \right)}{\partial p^*} \cdot \frac{p^*}{R^*}.
\]

Adding things up and simplifying, we find \(G^*_t = v^* \Omega^* (\theta \Omega^* + \epsilon_x^* + D^*)\). QED

**Proof of Proposition 4:**

We start by proving part (b). The schedules \(t^{MPA}(\lambda)\) and \(t^N(\lambda)\) are clearly continuous. The mean constraint and the continuity of \(t^{MPA}(\lambda)\) and \(t^N(\lambda)\) ensure the existence of at least one intersection. Consider one such intersection \(\hat{\lambda}\), so that \(t^{MPA}(\lambda) = t^N(\lambda)\). By the FOC, \(G^*_t(t^N(\lambda), \hat{\lambda}, k^{MPA}) = \psi\). Since \(G_t(t^N(\lambda), \hat{\lambda}) = 0\) this implies \(G^*_t(t^N(\lambda), \hat{\lambda}, k^{MPA}) = \psi\). Now if \(d G^*_t(t^N(\lambda), \lambda, k^{MPA}) = 0\) then \(G^*_t(t^N(\lambda), \lambda, k^{MPA}) = \psi\) for all \(\lambda\), which in turn implies \(G^*_t(t^N(\lambda), \lambda, k^{MPA}) = \psi\) for all \(\lambda\). Therefore the schedule \(t^N(\lambda)\) satisfies the FOC, hence \(t^{MPA}(\lambda) = t^N(\lambda)\) for all \(\lambda\) and \(k^{MPA} = k^*\).
We next prove part (a). Again, $t^{\text{MPA}}(\lambda)$ and $t^{N}(\lambda)$ must intersect at least once. We now argue that if $\frac{d}{dx}G_{i}(t^{N}(\lambda), \lambda, k^{\text{MPA}}) < 0$ for all $\lambda$ then $t^{\text{MPA}}(\lambda)$ can only intersect $t^{N}(\lambda)$ from above. This, together with continuity, will also ensure the uniqueness of the intersection.

We argue by contradiction. Suppose $t^{\text{MPA}}(\lambda)$ intersects $t^{N}(\lambda)$ at some point $\hat{\lambda}$ from below. Consider two values of $\lambda$ on the opposite sides of this intersection, $\lambda_1 < \hat{\lambda} < \lambda_2$, such that $t^{\text{MPA}}(\lambda_1) < t^{N}(\lambda_1)$ and $t^{\text{MPA}}(\lambda_2) > t^{N}(\lambda_2)$.

Recalling that $G_{i}(t^{N}(\lambda), \lambda) = 0$ for all $k^*$ and assuming $\frac{d}{dx}G_{i}^{*}(t^{N}(\lambda), \lambda, k^{\text{MPA}}) < 0$ for all $\lambda$ then

$$G_{i}^{W}(t^{N}(\lambda_2), \lambda_2, k^{\text{MPA}}) = G_{i}^{*}(t^{N}(\lambda_2), \lambda_2, k^{\text{MPA}})$$

$$< G_{i}^{*}(t^{N}(\lambda_1), \lambda_1, k^{\text{MPA}}) = G_{i}^{W}(t^{N}(\lambda_1), \lambda_1, k^{\text{MPA}})$$

These inequalities and the concavity of $G^{W}$ in $t$ imply

$$G_{i}^{W}(t^{\text{MPA}}(\lambda_2), \lambda_2, k^{\text{MPA}}) < G_{i}^{W}(t^{N}(\lambda_2), \lambda_2, k^{\text{MPA}})$$

$$< G_{i}^{W}(t^{N}(\lambda_1), \lambda_1, k^{\text{MPA}}) < G_{i}^{W}(t^{\text{MPA}}(\lambda_1), \lambda_1, k^{\text{MPA}}).$$

The claim follows. QED.

**Proof of Proposition 5**

As a first step, we argue that an increase in $k^*$ leads to a decrease in the degree of diversification $D^*$. We can write $D^* = 1 - \frac{\pi^*q^*}{\pi^*q^* + q_0} = 1 - \frac{1}{1 + \frac{q_0}{\pi^*q^*}}$. An increase in $k^*$ (holding $\pi^* = \ln p^*$ constant) leads to an increase in $q^*$ and a decrease in $q_0$, hence $D^*$ falls.

Next focus on $\Omega^*$. We have $\Omega^* = \frac{\pi^*c^*}{R^*} = \frac{\pi^*q^*c^* - \pi^*c^*}{R^*} = \frac{1}{1 + \frac{q_0}{\pi^*q^*}} - \frac{\pi^*c^*}{R^*}$. As $k^*$ increases, the first term in the above expression increases, as we argued above. Next note that $k^*$ affects the consumption share $\frac{\pi^*c^*}{R^*}$ only through $R^*$. In principle $\frac{\partial R^*}{\partial k^*}$ has an ambiguous sign, but note that under certainty $k^*$ maximizes $R^*$, hence $\frac{\partial R^*}{\partial k^*} = 0$ under certainty. If $p^*$ is uncertain but has a small support, $\frac{\partial R^*}{\partial k^*}$ will be small in absolute value, and hence $\frac{\partial}{\partial k^*}(\frac{\pi^*c^*}{R^*})$ will also be small in absolute value. This ensures that if the support is small enough, $\Omega^*$ is increasing in $k^*$.

Next note that a change in $k^*$ in general has an ambiguous effect on the export supply elasticity $\varepsilon_{x}^*$, so in general the effect of $k^*$ on $\Omega^*(\theta \Omega^* + \varepsilon_{x}^* + D^*)$ is ambiguous, however if risk aversion is sufficiently strong, i.e. if $\theta$ is sufficiently negative, then clearly the effect is negative. If $\varepsilon_{x}^*$ is approximately constant we do not require $\theta$ to be sufficiently negative.

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Finally, consider the sign of the whole expression (5.4). Letting $\Omega^* (\theta \Omega^* + \varepsilon^*_x + D^*) \equiv h(p^*, k^*)$, we can rewrite (5.4) as

$$\frac{\partial}{\partial k^*} [v^* (p^*, k^*) h(p^*, k^*)] = \frac{\partial v^*}{\partial k^*} h + v^* \frac{\partial h}{\partial k^*} = \left( \frac{v^*}{h} \right) \cdot h \cdot v^*$$  \hfill (8.1)

Note that the term $\frac{v^*}{h}$ is the relative change in real income due to a capital re-allocation. This is zero under certainty, and under uncertainty it necessarily changes sign over the range of $k^*$, since if it was always positive or negative there would be an incentive to re-allocate capital. We now argue that if $\theta$ is sufficiently negative and the support of $p^*$ is small enough, the expression above is negative. Fix $\theta$ at some level $\hat{\theta}$ such that $h < 0$ and $\frac{h_{k^*}}{h} > A > 0$ under certainty (where $A$ is some positive constant). The arguments above ensure that such $\hat{\theta}$ must exist. Next recall that $k^*$ satisfies $v^*_{k^*} = 0$ under certainty. Then, as the support of $p^*$ shrinks to zero, $\hat{\theta} \frac{h_{k^*}}{h}$ goes to zero for all $p^*$ in the support, while $\frac{h_{k^*}}{h}$ approaches $A > 0$, therefore

$$\frac{\partial}{\partial k^*} [v^* (p^*, k^*) h(p^*, k^*)] < 0. \quad \text{QED}$$

**Proof of Proposition 6:**

Focus on the case $(G_{tt}^* + G_{t\lambda}^*) \frac{dt^N}{d\lambda} + G_{t\lambda}^* < 0$, or equivalently $\frac{d}{d\lambda} G_t^*(t^N(\lambda), t^N(\lambda), \lambda) < 0$. The key is to prove the analog of Lemma 1, namely that $t^{MPA}(\lambda)$ intersects $t^N(\lambda)$ once and from above.

We argue by contradiction. Suppose $t^{MPA}(\lambda)$ intersects $t^N(\lambda)$ at some point $\hat{\lambda}$ from below. Consider two values of $\lambda$ on the opposite sides of this intersection, $\lambda_1 < \hat{\lambda} < \lambda_2$, such that $t^{MPA}(\lambda_1) > t^N(\lambda_1)$ and $t^{MPA}(\lambda_2) > t^N(\lambda_2)$.

Recalling that $G_t(t^N(\lambda), t^N(\lambda), \lambda) = 0$ and $\frac{d}{d\lambda} G_t^*(t^N(\lambda), t^N(\lambda), \lambda) < 0$ for all $\lambda$, then

$$\tilde{G}_t(t^N(\lambda_2), \lambda_2) = G_t^*(t^N(\lambda_2), t^N(\lambda_2), \lambda_2) < G_t^*(t^N(\lambda_1), t^N(\lambda_1), \lambda_1) = \tilde{G}_t(t^N(\lambda_1), \lambda_1)$$

These inequalities and the concavity of $\tilde{G}$ in $t$ imply

$$\tilde{G}_t(t^{MPA}(\lambda_2), \lambda_2) < \tilde{G}_t(t^N(\lambda_2), \lambda_2) < \tilde{G}_t(t^N(\lambda_1), \lambda_1) < \tilde{G}_t(t^{MPA}(\lambda_1), \lambda_1)$$

This contradicts the FOC, which requires that $\tilde{G}_t(t^{MPA}(\lambda), \lambda)$ be equalized across states.

Having proved the analog of Lemma 1, the claim of the proposition follows immediately: just observe that the assumed single crossing properties imply $t^N(\lambda)$ and $t^{MPA}(\lambda)$ are increasing, and apply a similar argument to that in the proof of Proposition 1. QED
Figure 1
Noncooperative Policy vs. Mean Preserving Agreement

Figure 2
Figure 3
US ln tariff factor (detrended) 1903-33 vs. ln(Adj. Openess) Cuba (CRRA=-5).

Table 1
Correlation test for uncertainty-reducing motive
(US non-cooperative tariff and Cuban adjusted openness pre-1934)

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<td>0.57</td>
<td>0.57</td>
</tr>
</tbody>
</table>

Notes: Spearman rank correlation between (detrended) US ln tariff factor and adjusted openness for Cuba between 1903-1933. *** 1%, ** 5%, significantly different from 0.