CITP
CENTRE FOR INCLUSIVE TRADE POLICY

Preferential trade agreements under uncertainty

Nicolò Tamberi

October 2023

Centre for Inclusive Trade Policy
Working Paper No.007

UKRI Economic and Social Research Council

Centre for Inclusive Trade Policy
https://citp.ac.uk/
info@citp.ac.uk

Established in 2022, the Centre for Inclusive Trade Policy (CITP) is the first research centre dedicated to trade policy to be funded by the Economic and Social Research Council. As a centre of excellence for innovative research on trade policy and its inclusiveness, we aim to equip the UK with the capability to formulate and implement a trade policy tailored to the needs of the whole of the UK, while recognising the importance of the multilateral trading system and the UK's role within it. The CITP is funded by the Economic and Social Research Council [grant number ES/W002434/1]

Abstract

In Preferential Trade Agreements (PTAs), not all firms utilise preferential tariffs, suggesting the presence of fixed costs of using tariff preference. I develop a model where firms can trade in a PTA under the standard Most Favoured Nation regime or, after paying an additional fixed cost, under the Preferential regime. I show that if tariff preferences become uncertain, more firms export under the MFN regime, but with the option to switch to the Preferential regime in the future. The model extends the Handley and Limão one and nests its empirical equation under the restriction of a single trade regime. I apply the model to an excellent natural experiment: the Brexit referendum and UK trade with PTA partners. I find that ignoring the partial uptake of trade agreements understates the impact of uncertainty on trade and can lead to biased empirical results. Brexit uncertainty had a modest negative effect on UK imports from PTA countries. Continuity Agreements signed to replace the existing EU agreements only partly reduced the uncertainty introduced by the referendum.

Suggested citation

Tamberi, N (2023) Preferential trade agreements under uncertainty. Centre for Inclusive Trade Policy, Working Paper 007

Non-Technical Summary

In Preferential Trade Agreements, firms can trade under a preferential regime, which gives them access to lower customs tariffs compared to the Most Favoured Nation (MFN) tariffs, the default for members of the World Trade Organization. However, although tariff preferences are available for trade between PTA members, not all firms use them. The partial uptake of tariff preferences suggests the presence of some additional costs related to the utilisation of PTAs. Such costs can be related to bureaucratic procedures or compliance with Rules of Origin, for instance, and they create regime heterogeneity.

In this paper, I ask what happens when tariff preferences granted under a trade agreement become uncertain, with the possibility for trade to revert to the MFN regime. While in general trade agreements are believed to reduce uncertainty between trading partners, in recent times trade policy uncertainty increased within trade agreements, with episodes such as Brexit and the NAFTA renegotiation.

To study uncertainty in trade agreements, I use a theoretical model that accounts for the partial uptake of tariff preferences in trade agreements. I show that when preferential tariffs become uncertain, only firms that would choose the preferential regime in the absence of uncertainty are concerned with the potential loss of preferential tariffs. These firms prefer to export under the MFN regime and consider switching to the preferential one in case uncertainty resolves. As more firms trade under the MFN rather than the preferential regime with uncertainty, total trade values are reduced by a factor proportional to the margin between the MFN and preferential tariffs. The proposed in this paper model extends the current state-of-the-art models of trade policy uncertainty and provides a new tool to study uncertainty in trade agreements.

I apply the model to the UK's trade with its trade agreement partners following the 2016 Brexit referendum. As a member of the EU, the UK had trade agreements with about 70 countries beyond the EU, and by leaving the EU the UK was also leaving all these other trade agreements. This generated substantial uncertainty about the future trade regime between the UK and its trade agreement partners, with a concrete probability of trade reverting to the MFN regime. To counteract this uncertainty, the UK government started to re-negotiate those agreements and, to date, managed to roll over most of them by signing Continuity

Agreements.

Empirical results show that the uncertainty generated by the 2016 referendum negatively affected UK's imports from its PTA partners. Continuity Agreements mitigated the negative effect of uncertainty but did not offset it completely – they reduced uncertainty by a third on average. The analysis shows that accounting for the partial uptake of trade agreements is a key factor for identifying uncertainty effects in the data.

Finally, I use the parameters estimated from data on UK imports to construct a measure that tracks the evolution of uncertainty over time, and I quantify its effects on UK imports from trade agreement partners. I find that the major source of uncertainty has been the 2016 referendum. Uncertainty then fell in 2017-18 only to increase again and get close to referendum levels by the end of 2019, in concomitance with a series of political events in the UK. A partial equilibrium quantification exercise shows that by the end of 2019, uncertainty reduced UK's imports from PTA partners by -1.1%. Continuity Agreements helped to mitigate these effects but did not completely offset uncertainty, bringing the reduction in UK imports by the end of 2019 from -1.1% to -0.75%.

CITP
CENTRE FOR INCLUSIVE TRADE POLICY

WORKING PAPER

Preferential trade agreements under uncertainty

Nicolò Tamberi*

Abstract
In Preferential Trade Agreements (PTAs), not all firms utilise preferential tariffs, suggesting the presence of fixed costs of using tariff preference. I develop a model where firms can trade in a PTA under the standard Most Favoured Nation regime or, after paying an additional fixed cost, under the Preferential regime. I show that if tariff preferences become uncertain, more firms export under the MFN regime, but with the option to switch to the Preferential regime in the future. The model extends the Handley and Limão one and nests its empirical equation under the restriction of a single trade regime. I apply the model to an excellent natural experiment: the Brexit referendum and UK trade with PTA partners. I find that ignoring the partial uptake of trade agreements understates the impact of uncertainty on trade and can lead to biased empirical results. Brexit uncertainty had a modest negative effect on UK imports from PTA countries. Continuity Agreements signed to replace the existing EU agreements only partly reduced the uncertainty introduced by the referendum.

Keywords: Trade agreements; Policy uncertainty; Brexit

JEL classification: F 13; F 14; F68

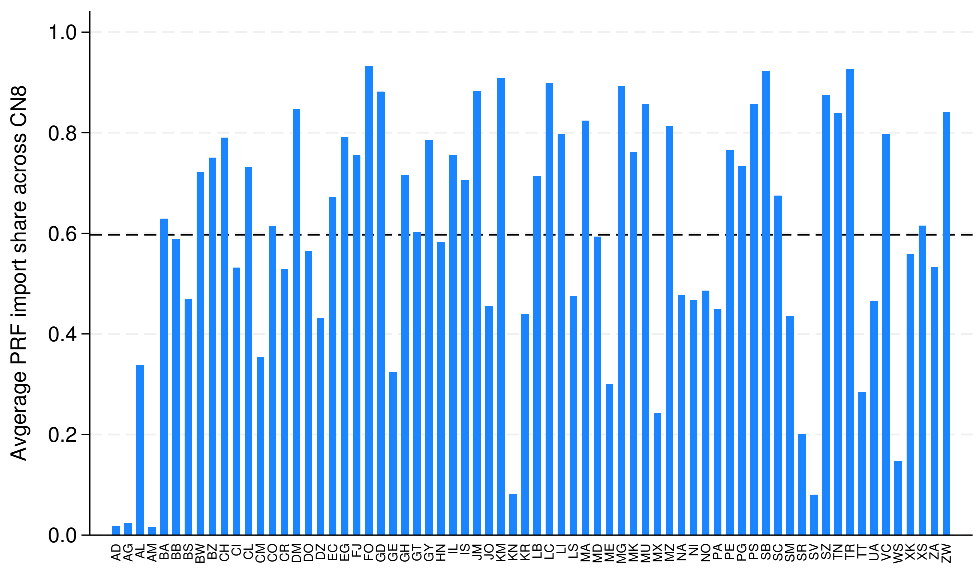
*University of Sussex. Email: N.Tamberi@sussex.ac.uk

1 Introduction

In Preferential Trade Agreements (PTAs) firms can trade under a preferential (PRF) regime, which gives them access to lower customs tariffs compared to the Most Favoured Nation (MFN) ones, the default for members of the World Trade Organization. However, although tariff preferences are available for trade between PTA members, not all firms use them.

Data are clear on this. Figure 1 shows the average preference utilisation rate across the products for UK imports from PTA partners. The average preference utilisation rate is 58% with great variation across countries, even among large exporters. For instance, the average rate is 93% for Turkey, 49% for Norway and as low as 25% for Mexico.[1] The partial uptake of tariff preferences suggests the presence of some additional costs related to the utilisation of PTAs. Such costs can be related to bureaucratic procedures or compliance with Rules of Origin, for instance, and they create regime heterogeneity.

Figure 1: Share of UK imports under preferential regime, 2013-15



Source: author's calculation based on Eurostat imports data for the UK and ITC MacMap tariff data for 2013-15. The figure shows the average share of preferential trade across CN 8-digit products with a positive MFN tariff. The horizontal line shows the average across countries.

What happens if a PTA becomes uncertain? Trade under uncertainty has been increasingly

[1] The share is computed on Combined Nomenclature (CN) 8-digit products with non-zero MFN tariff over 2013-15, and excluding processing trade which is subject to tariff rebates.

under the scrutiny of scholars (see Handley and Limão (2022)). Exporting often involves an initial sunk cost, hence uncertainty about future market conditions can deter firms from starting to export. While in general PTAs are believed to reduce uncertainty as they show commitments (Limão (2016)), in recent times trade policy uncertainty increased *within* PTAs, with episodes such as Brexit and the NAFTA renegotiation. The possibility of losing tariff preferences together with a fixed cost associated with their use can deter firms from exporting. However, why would exporters care about losing preferential tariffs if such tariffs are not used?

In this paper I develop a model of trade between PTA partners under uncertainty where accessing preferential tariffs entails an additional cost compared to the standard MFN regime. The model features regime heterogeneity, with firms trading under both the MFN and PRF regimes. I show that when preferential tariffs become uncertain, only firms that would choose the preferential regime in the absence of uncertainty are concerned with the potential loss of preferential tariffs. These firms prefer to export under the MFN regime and consider switching to the preferential one in case uncertainty resolves.

Uncertainty affects extensive margin decisions as it entails a risk. The risk associated with an event is defined as the product of: i) the probability of the event occurring; ii) the exposure to the event; and iii) the potential loss. I use the model to derive an empirical equation with a theory-consistent measure of risk in a PTA. I show that the product-level risk in a PTA can be measured as the product of the share of imports coming under the preferential (measuring exposure) and the margin between the preferential and MFN tariff (measuring the potential loss), with the probability of the event occurring left as a parameter to be estimated.

The model extends the one of Handley and Limão (2015) and Handley and Limão (2017) (henceforth HL) which is now a benchmark for applied research on trade policy uncertainty. The HL model features one trade regime only, and uncertainty about future market conditions generates an option value of waiting, reducing entry into exporting. The extensive margin response is then reflected in the aggregate export value as fewer firms trade under uncertainty. The HL model is attractive for applied research as it yields an intuitive difference-in-differences equation comparing products with different tariff margins before and after some uncertainty shock. In my model firms can trade both under the MFN and PRF regimes, and the empirical equation that I derive nests the one of the HL model under the assumption of a single trade regime.

The model proposed in this paper applies when firms can serve a foreign market under different trade regimes. The trade regimes considered here have the following characteristics: a) they differ in terms of variable trade costs; b) the firm can choose them; c) accessing the low variable cost regime entails an additional sunk cost. The model will apply to any situation where, by making an initial sunk investment, the firm can lower its variable costs, and where uncertainty affects only one regime. While uncertainty about the sunk cost to access the preferential regime could be modelled as well, this is left for future research.

I test the model using an excellent natural experiment: UK's trade with its PTA partners following the 2016 Brexit referendum on leaving the European Union (EU). As a member of the EU, the UK had trade agreements with about 70 countries beyond the EU, and by leaving the EU the UK was also leaving all these other trade agreements. This generated substantial uncertainty about the future trade regime between the UK and its PTA partners, with a concrete probability of trade reverting to the MFN regime. To counteract this uncertainty, the UK government started to re-negotiate those agreements and managed to roll over most of them by signing Continuity Agreements (CAs).

The empirical application seeks to answer multiple research questions. First, I construct a Wald test for nested models to test for the restriction of full exposure to uncertainty. The restriction is rejected by the data. Second, I show that ignoring information on exposure to the potential tariff increase can lead to substantially different conclusions about the effects of uncertainty on trade flows. Third, I measure the impact of Brexit uncertainty on the UK's trade with PTA countries, which is an important policy question. Finally, I test whether the signature of Continuity Agreements between the UK government and the PTA partners removed the uncertainty generated by the 2016 referendum. Given the staggered roll-out of the CAs, I use state-of-the-art econometric techniques to deal with it.

The paper has three main contributions. First, I extend the HL model to regimes with conditional tariff preferences where not all exporters use preferential tariffs. In these regimes, the trade policy uncertainty measure of the HL model no longer applies, and preference utilisation rates must be accounted for. Given the recent increase in renegotiations of PTAs this can be an important extension of the standard model allowing researchers to study uncertainty in PTAs. Second, I exploit data on preference utilization in a structural model of trade. To the best of my knowledge, this is the first paper that incorporates preference utilisation in a structural model and uses them to derive an empirical equation. I do so in the context of trade policy uncertainty, but the model nests the deterministic scenario as a special case. The last contribution is empirical. To estimate the impact of the Continuity Agreements, I adapt the flexible regression method of Wooldridge (2021) to a triple-difference estimator. I believe that such a setting can be common with trade data and the empirical approach can therefore be useful to other researchers.

Empirical results show that the uncertainty generated by the 2016 referendum negatively affected UK's trade with its PTA partners. Continuity Agreements mitigated the negative effect of uncertainty but did not offset it completely – they reduced uncertainty by a third on average. I find marked differences between my model and the one of HL. While my model finds strong uncertainty effects, the HL model does not. I ascribe these differences to a misspecification of the empirical equation in the context of conditional preferences.

Finally, I use the regression estimates to construct a model-consistent measure that tracks the evolution of the probability of policy reversal over time. I find that the 2016 referendum has been the major source of uncertainty, which fell in 2017-18 only to increase again and get close to referendum levels by the end of 2019. A partial equilibrium counterfactual shows that by the end of 2019, uncertainty reduced UK's imports from PTA partners by -1.1%. Continuity Agreements helped to mitigate these effects but did not completely offset uncertainty, bringing the reduction in UK imports by the end of 2019 from -1.1% to -0.75%.

1.1 The UK, PTA partners and Brexit

In 2015 the UK had PTAs with 54 countries which accounted for 10% of its imports and 14% of its exports. These countries are of different natures. Some are long-lasting trade partners such as Switzerland (since 1973) or Turkey (since 1995), while other trade agreements are more recent. The EU negotiated these agreements from a position of strength thanks to its important economic size. For many partners, mainly the neighbouring ones, trade agreements come with a unified Rules of Origins framework – the Pan-Euro-Mediterranean Convention (PEM) – which allows for cumulation across the PTA partners of the EU.[2] The strong negotiating position of the EU implies that trade partners are often adopting its standards and regulations, a fact that contributed to the creation of 'factory Europe' as described by Baldwin and Lopez-Gonzalez (2015).

After the 2016 Brexit referendum, preferential trade between the UK and PTA partners became uncertain. At the time of the referendum and for some time to come, it was not clear what the future relation between the UK and the EU would have been. Even more uncertain was the future of the UK's trade policy beyond the EU. While the UK government officially announced that it was leaving the EU by invoking Article 50 of the EU Treaty in March 2017, it was not until the end of 2017 that it made clear its intention to roll over existing PTAs with the Trade Bill 2017-19.[3] When the bill was passed, the deadline for leaving the EU with or without a deal was set in March 2019. Commentators considered the government's plan to roll over all PTAs by that date very ambitious, and with good reasons.

In January 2019, three months before the original departure from the EU, the UK had not signed any Continuity Agreement. By the end of February 2019, the UK signed CAs with only 9 countries, covering 6 out of 40 of the original EU PTAs (see Magntorn Garrett (2019 (Online)(b))). Although to date the UK managed to sign CAs with most partners, in 2019 uncertainty regarding its ability to lock in existing preferences was pervasive.[4]

The aim of the CAs was to maintain current preferences and remove uncertainty. As we can read from the explanatory notes prepared for the UK Parliament by the Department for International Trade (DIT), with Continuity Agreements 'the Government has sought to deliver the maximum possible certainty to businesses and consumers through ensuring continuity in the UK's existing trade relationships.' The CAs try to replicate as closely as possible the provisions of

[2] See https://trade.ec.europa.eu/access-to-markets/en/content/pan-euro-mediterranean-convention-pem
[3] See https://bills.parliament.uk/bills/2172
[4] To date the UK government signed CAs with 66 PTA partners and only six countries remain uncovered.

the EU PTAs, and they are often in a 'short form' which sees the EU agreements applied *mutatis mutandi.* Changes can be as simple as replacing 'EU' with 'UK' in the text of the agreement or more complicated such as adjusting quotas to reflect the size of the UK market.

However, changes are not always so smooth. As documented by the UK Trade Policy Observatory (Gasiorek and Holmes (2017)), what appears to be bilateral is often trilateral. The issue of cumulation in Rules of Origins can have important implications, in particular for sectors where UK and EU supply chains are strongly entwined. This is because only goods which are considered originating can benefit from preferential treatment. Under the EU PTAs, all materials originating and processing carried out in any of the 27 EU member states count as of EU origin. In the CAs signed by the UK, EU materials can be considered as originating in the CA signatory parties, but this is not always the case for EU processing. Moreover, in some cases the CA states that EU materials and processing can be considered originating indefinitely (e.g., the UK-Andean agreement) but in other cases recognition of EU materials and processing in the CA was limited to a period of three years (e.g., see DIT 2019a for UK-South Korea or DIT 2020 for UK-Mexico). Finally, it should also be considered that cumulation of Rules of Origins in CAs only applied bilaterally between the CA signatories without including each signatory's trade with the EU.

Apart from cumulation, there could be other details of EU PTAs which are difficult to replace with Continuity Agreements. For instance, the EU-Switzerland relation is characterised by a multitude of agreements (one for tariffs, one for mutual recognition, one for free movement, and many others) and, as stated by the DIT report on the UK-Switzerland CA, it was not possible to replicate some of the existing provisions as they depended on the not yet defined UK-EU trade arrangements (DIT 2019b paragraph 12). Given that the rollover is often incomplete and subject to conditions, it is not obvious whether CAs removed all the uncertainty. While the UK government has sought to deliver 'the maximum possible certainty', whether it succeeded in overturning the uncertainty spurred by the 2016 referendum is ultimately an empirical question.

To add to the uncertainty, the announcement of the UK no-deal MFN tariffs arrived in 2019. As discussed by Gasiorek, Magntorn Garrett and Winters (2019 (Online)), in March 2019 the UK Government published a temporary tariff schedule that would have replaced EU MFN tariffs in case of a no-deal exit from the EU. Under the proposed no-deal schedule, around 72% of UK's 8-digit tariff lines would have seen a reduction, with many tariffs going to zero. Importantly, the new schedule would have taken about 95% of the tariff lines to zero compared to 26% under the EU MFN schedule. The proposed tariff schedule has then been updated in October 2019, broadly replicating the March proposal (see Magntorn Garrett (2019 (Online)(a))). In the end, these proposed no-deal tariffs were never applied by the UK but given that a large portion of tariff lines was brought down to zero, if this tariff schedule was perceived as credible it might have considerably lowered uncertainty by removing the MFN tariff threat. However, the fact that the tariff schedule was explicitly temporary might have induced exporters to not consider it for long-term investment decisions. In the empirical section, I will address this issue directly with data.

Overall, we have two sorts of uncertainty affecting the UK's tariff schedule. First and foremost, the exit from the EU and the potential exit from the PTAs, with trade reverting to the MFN regime. Second, a potential change in the MFN tariff schedule of the UK with the no-deal tariffs. The empirical analysis will look at these two issues directly.

1.2 Related literature

1.2.1 Trade under uncertainty

In the HL model uncertainty about future tariffs creates an option value to wait reducing entry into exporting. The main result of HL for empirical applications is that the response to trade policy uncertainty depends on the margin between a potentially applied high tariff and a lower currently applied tariff. The response to uncertainty differs across products because of differences in the tariff margin across products. This provides the empirical variation across products, which combined with variation in uncertainty shocks over time allows researchers to estimate a difference-in-differences model.

The model was applied to study several instances of trade policy uncertainty. Handley and Limão (2015) estimate that Portugal's accession to the EC removed trade policy uncertainty (TPU) related to the tariffs applied by the EC and Spain to Portuguese exports, and that uncertainty removal had large positive effects on both the extensive and intensive margins. Handley and Limão (2017) apply the model to China's accession to the WTO and the removal of uncertainty for China's exports to the US with product-level data. Feng, Li and Swenson (2017) also exploit China's accession to the WTO, this time using a dataset at the firm-product level. They find that the removal of uncertainty induced both entry and exit of Chinese firms into export activity to the US and the EU, as well as effects on product prices and quality. Crowley, Meng and Song (2018) estimate the effect of uncertainty induced by anti-dumping on Chinese firms exploiting the fact that applications of anti-dumping duties tend to be correlated across countries. Handley (2014) shows that uncertainty about `water' in tariffs – the gap between MFN applied and WTO bound tariffs – also has negative effects on trade. Looking at Australia's removal of this gap, he finds that Australia's import growth would have been 7% lower if binding uncertainty had not been removed.

In the context of Brexit and UK-EU trade, Crowley, Exton and Han (2020) look at entry and exit into exporting and find evidence of TPU affecting the number of firms exporting to the EU but not the value of exports. Their estimates suggest that in response to Brexit uncertainty, 4,678 firms did not start exporting new products to the EU by December 2016. Graziano, Handley and Limão (2021), who also model variation of uncertainty over time, find that UK-EU trade started to react to Brexit-related TPU in the run-up to the referendum results, both on the extensive and intensive margin. Graziano, Handley and Limão (2020) apply the framework of Graziano, Handley and Limão (2021) to UK trade with PTA partners prior to the 2016 referendum, and to the best of my knowledge, this is the only study that looked at PTA partners. In this case, the authors model uncertainty over time but do not consider preference utilisation rates. Focusing only on a subset of EU PTAs Graziano, Handley and Limão (2020) find evidence that uncertainty on the Brexit referendum results negatively affected UK's trade with its PTA partners.

1.2.2 Preference utilisation

A second strand of literature related to this paper is the one on preference utilisation in trade agreements. Many studies use product-level data, but the focus is shifting to transaction-level data as these become available (e.g., Kasteng, Kokko and Tingvall (2022) or Krishna et al. (2021)). The literature tends to find that the preference utilisation rate (PUR) is positively correlated with the tariff margin as well as with the value of trade flows (see for instance Hakobyan (2015) and Bureau, Chakir and Gallezot (2007)). However, Manchin (2006) finds that after accounting for the selection into asking for preferences, the tariff margin does not affect the amount of preferential trade. Similar results are obtained by Agostino, Demaria and Trivieri (2010), who use estimated costs of compliance with preference utilisation criteria in a gravity regression.

Various researchers suggest that the costs associated with preference utilisation are mostly fixed rather than variable. As explained in Keck and Lendle (2012), the fact that the value of exports has explanatory power on the PUR after controlling for the tariff margin indicates the presence of fixed costs, as given a tariff saving rate, larger trade volumes are associated with higher PUR. Moreover, the authors find that export value explains more variation in the PUR than the tariff margin, and they conclude that 'utilization costs are principally of a fixed cost nature'.

Using data on the survey of Japanese affiliates to study the relation between exporter size and preferences utilisation, Hayakawa (2015) finds that firm size matters more for preferences utilisation than for exporting, and he suggests that fixed costs associated with preferences utilisation might be even larger than those associated with exporting. Hayakawa, Kim and Lee (2014) use South Korea customs data to analyse the South Korea-ASEAN trade agreement. They find that rules of origin restrictiveness, tariff margin and export volumes are all determinants of preference utilisation, although the scale effect has the largest impact. This is interpreted as the presence of fixed costs daunting small exporters.

Analysing EU imports data, Nilsson and Dotter (2012) suggest that the nature of costs related to preferential trade is more likely of fixed rather than variable nature. Focusing on a transaction-level dataset for Iceland, Albert and Nilsson (2016) quantify the fixed costs associated with the preference utilisation of EU exports to Iceland to be around €20 to €260. Ulloa and Wagner (2012) use data on Chilean exports to the US and estimate that the compliance cost is around US$3,000 and that applying for preferences would be worth only for shipments with a value above US$80,000. They also find that the cost decreased substantially over time, implying learning-by-doing.

Takahashi and Urata (2010) analyse a survey of Japanese firms and find that large firms are more likely to utilise tariff preferences. They also suggest that, because after having obtained a certificate of origin a firm has no limit in export quantity deemed originating, the costs of obtaining origination status are mostly fixed. However, it should be recognised that in order to obtain originating status a firm might deviate its input sourcing away from the most efficient supplier, hence contributing to higher variable costs.

2 Theory

I extend the HL model to account explicitly for the fact that under a PTA not all exporters choose to trade under the preferential regime. This outcome arises in my model because accessing preferences involves additional fixed costs compared to the MFN regime, so only the most productive firms choose the preferential regime.

Given the additional sunk cost of the preferential regime, when tariff preferences become uncertain more firms start exporting under the MFN regime than without uncertainty and consider the option to switch to the preferential regime in the future. The key ingredient for this result is the complementarity of sunk costs across the two regimes. All exporters must pay an initial sunk cost, both under the MFN and PRF regime, and an additional cost is required to access tariff preferences. Hence, by switching to the PRF regime in the future there is no loss in terms of sunk costs. This implies that firms waiting to choose whether to access the PRF regime or not can trade under the MFN regime in the meantime.

For total exports, this means that under uncertainty more firms pay the MFN rather than the PRF tariff. Hence, export values are reduced. As in the HL model, this negative impact on exports is proportional to the PRF/MFN tariff margin, but we now have to account for the preference utilisation rate as well. While uncertainty about fixed costs could be modelled as well, this is left for future research.

The basis of the model is Melitz (2003) with CES preferences over differentiated goods characterised by an elasticity of substitution $\sigma > 1$ and an outside numeraire good, as in HL. Firms are heterogeneous in productivity φ and operate in monopolistic competition using labour as the only input in production. Deterministic versions of the model were also used by Demidova and Krishna (2008) and Hayakawa, Naoto et al. (2019). I confine the full description of the background settings to the Appendix. In the deterministic model, an exporter of product h from country i can export to a PTA partner country j under two regimes: the MFN or the preferential (PRF) regime. Under the MFN regime, exporters pay an initial sunk cost f_{hij} and face the MFN tariff τ_{hjt}^{MFN} (= 1 + MFN tariff). Alternatively, exporters can pay an additional sunk cost f_{hij}^{PRF} (hence a total of $f_{hij} + f_{hij}^{PRF}$) and face the preferential tariff $\tau_{hijt}^{PRF} < \tau_{hjt}^{MFN}$ (similarly,

$\tau_{hijt}^{PRF} = 1$ + PRF tariff). The additional sunk cost f_{hij}^{PRF} summarises the fixed cost of accessing preferences. These can be complying with Rules of Origins and dealing with border formalities related to preferential access.

2.1 Deterministic scenario

With CES preferences and monopolistic competition, each firm faces the residual demand $q_{hijt} = p_{hijt}^{-\sigma}\mu Y_{jt} P_{jt}^{\sigma-1}$ in time t and its optimal price charged to consumers (so tariff-inclusive) is the constant markup over marginal cost $p_{hijt}^{*} = \frac{\sigma}{\sigma-1}\frac{\delta_{ij}\tau_{hijt}}{\varphi}$, where the wage rate is set to unity because of the numeraire. Y_{jt} is aggregate income of importing country j, μ is the constant share of income spent on the differentiated good, P_{jt} is the CES price index of j, $\delta_{ij} \geq 1$ are iceberg trade costs between i and j, $\tau_{hijt} \geq 1$ is defined as one plus the *ad valorem* tariff and φ is the productivity of the firm. Labour is the only factor of production and wages are pinned down to unity by the numeraire good.

Total sales at consumer prices are $q_{hijt}p_{hijt} = p_{hijt}^{1-\sigma}\mu Y_{jt} P_{jt}^{\sigma-1}$. However, exports revenues received by the firm are given by $q_{hijt}p_{hijt}/\tau_{hijt}$ because tariff revenues are collected by the importing country (on the other hand, iceberg transport costs are passed onto consumers). Under the MFN regime the firm receives $\pi_{hijt}^{MFN}(\varphi) = q_{hijt}p_{hijt}/\tau_{hijt}^{MFN} = A_{ijt}\left(\tau_{hjt}^{MFN}\right)^{-\sigma}\varphi^{\sigma-1}$ and under the PRF regime revenues are $\pi_{hijt}^{PRF}(\varphi) = A_{ijt}\left(\tau_{hijt}^{PRF}\right)^{-\sigma}\varphi^{\sigma-1}$ with $A_{ijt} = \left(\frac{\sigma}{\sigma-1}\delta_{ij}\right)^{1-\sigma}\mu Y_{jt}P_{jt}^{\sigma-1}$ summarising market conditions. Firms are forward-looking and operate with an infinite time horizon and discount factor $\beta < 1$, and take the price index as given. It follows that a firm will choose to export under the MFN regime if the present value of exporting $V_{hijt}^{MFN} = \frac{\pi_{hijt}^{MFN}(\varphi)}{1-\beta}$ covers the sunk cost f_{hij}. Setting $V_{hijt}^{MFN} = f_{hij}$ and solving for φ we can find the productivity cut-off φ_{hijt}^{MFN} above which firms will export:

$$\varphi_{hijt}^{MFN} = \left[\frac{f_{hij}\left(1-\beta\right)}{A_{ijt}\left(\tau_{hjt}^{MFN}\right)^{-\sigma}}\right]^{\frac{1}{\sigma-1}} \tag{1}$$

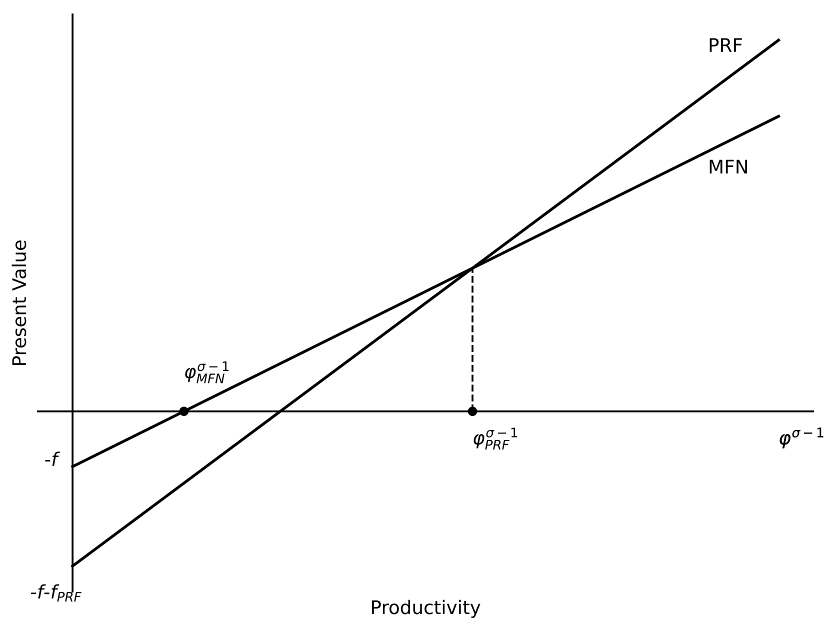
Given that trade under the preferential regime involves higher sunk costs and lower variable costs than the MFN regime, only more productive firms will select into the preferential regime. This result is the parallel of the exports and FDI nexus of Helpman, Melitz and Yeaple (2004). The sunk costs of exporting under the PRF regime are given by $f_{hij} + f_{hij}^{PRF}$. To find the cut-off for preferential trade, set $V_{hijt}^{PRF} - V_{hijt}^{MFN} = f_{hij}^{PRF}$, with $V_{hijt}^{PRF} = \frac{\pi_{hijt}^{PRF}(\varphi)}{1-\beta}$, and solve for productivity to find:

$$\varphi_{hijt}^{PRF} = \left[\frac{f_{hij}\left(1-\beta\right)}{A_{ijt}\left(\tau_{hjt}^{MFN}\right)^{-\sigma}} \right]^{\frac{1}{\sigma-1}} \left[\frac{f_{hij}^{PRF}/f_{hij}}{\left(\tau_{hjt}^{MFN}/\tau_{hijt}^{PRF}\right)^{\sigma}-1} \right]^{\frac{1}{\sigma-1}} = \varphi_{hijt}^{MFN} \times F_{hijt} \tag{2}$$

that is, the PRF cut-off is equal to the MFN one multiplied by a factor $F_{hijt} = \left[\frac{f_{hij}^{PRF}/f_{hij}}{\left(\tau_{hjt}^{MFN}/\tau_{hijt}^{PRF}\right)^{\sigma}-1} \right]^{\frac{1}{\sigma-1}}$ which summarises the fixed vs variable costs differential between the MFN and PRF strategies. If the proportional increase in sunk cost f_{hij}^{PRF}/f_{hij} is high or if the difference between MFN and PRF tariff is small ($\tau_{hjt}^{MFN}/\tau_{hijt}^{PRF} \sim 1$), then the PRF cut-off will be high meaning that only a small fraction of firms will find it profitable to trade under the preferential regime.[5]

To summarise the deterministic model, the value functions and the cut-offs of the MFN and PRF export strategies are plotted in Figure 2.

Figure 2: Value functions deterministic model



[5] In this model, we observe both MFN and PRF trade if the relative fixed and variable costs are within a certain range. The conditions are reported in the Appendix.

2.2 Uncertainty scenario

I now introduce uncertainty about preferences akin to HL. A new exporter of product h from country i which decides whether to export to PTA partner country j in period t has two options. She can choose the preferential regime, but now with uncertainty about future preferential tariffs. The uncertainty is about whether in the next period preferences will remain in place or if these will be revoked and she will have to pay the MFN tariff.

Alternatively, she can export under the MFN regime, with no uncertainty about future MFN tariff rates, and switch to the PRF regime when uncertainty resolves. Since MFN tariffs are not uncertain, the MFN entry cut-off is the same as in the deterministic scenario φ_{hijt}^{MFN}. This is because the possibility to switch to the PRF regime in the future is not considered by all exporters, but only by those productive enough to choose the PRF regime without uncertainty.

The availability of the MFN strategy and the complementarity of the initial sunk costs imply that no firm will find it optimal to wait to export. The complementarity of sunk costs means that there is nothing to lose by starting the MFN strategy today. Because waiting gives zero immediate profit, the starting under the MFN regime always dominates waiting.

On the other hand, uncertainty about preferential tariffs pushes the PRF cut-off upward, and accessing preferences become less attractive. The uncertain PRF regime has current tariff τ_{hijt}^{PRF} but expected future tariffs $E_t(\tau')$ drawn from a distribution $H(\tau')$ which can vary across industries but it is assumed fixed in time. The present value of exporting under the preferential regime is:

$$V_{hijt}^{PRF} = \pi(\tau_{hijt}^{PRF}) + \beta\left[(1-\gamma)V_{hijt}^{PRF} + \gamma E_t V(\tau')\right] \tag{3}$$

where $\pi(\tau_{hijt}^{PRF})$ is the immediate profit at the current preferential tariff τ_{hijt}^{PRF}, β is a discount factor and γ is the probability of a policy change in $t+1$ as perceived by the exporter. Equation (3) says that if in the next period nothing changes – which happens with probability $(1-\gamma)$ – the present value of the PRF regime in $t+1$ will be the same as today. If it changes, the expected continuation value is $E_t V(\tau') = \frac{E_t \pi(\tau')}{1-\beta}$. This solves to:

$$V_{hijt}^{PRF} = \frac{\pi(\tau_{hijt}^{PRF})}{1-\beta+\beta\gamma} + \frac{\beta\gamma}{1-\beta}\frac{E_t\pi(\tau')}{1-\beta+\beta\gamma} \tag{4}$$

This strategy involves sunk costs $f_{hij} + f_{hij}^{PRF}$. On the other hand, if the firm starts selling under the MFN regime today she can consider the option to switch to the preferential regime in the future in case of favourable conditions by paying the additional cost f_{hij}^{PRF}, which will occur with probability $H(\bar{\tau})$. Here $\bar{\tau}$ is the future tariff rate below which choosing the PRF regime is optimal. Hence the present value of the MFN regime for those that consider switching is:

$$V_{hijt}^{MFN} = \pi(\tau_{hjt}^{MFN}) + \beta(1-\gamma)V_{hijt}^{MFN} + \beta\gamma\left[H(\bar{\tau})\left(E_t V(\tau'|\tau' \leq \bar{\tau}) - f_{hij}^{PRF}\right) + (1-H(\bar{\tau}))\, V_{hijt}^{MFN}\right] \quad (5)$$

where $\pi(\tau_{hjt}^{MFN})$ is the immediate profit at the current MFN tariff. Tomorrow, with probability $1-\gamma$ nothing will change so the present value remains the same. With probability $\gamma H(\bar{\tau})$, where $H(\bar{\tau})$ is the probability that $\tau' \leq \bar{\tau}$, the policy change is favourable and the firm switches to the preferential regime after paying the extra cost f_{hij}^{PRF}. Finally, with probability $\gamma(1-H(\bar{\tau}))$ the policy will change but the firm will still prefer the MFN to the PRF regime. This is because the new tariff τ' is above the threshold $\bar{\tau}$ below which the firm would prefer the PRF to the MFN regime. The continuation value of the firm under MFN solves to:

$$V_{hijt}^{MFN} = \frac{\pi(\tau_{hjt}^{MFN})}{1-\beta+\beta\gamma H(\bar{\tau})} + \frac{\beta\gamma H(\bar{\tau})}{1-\beta+\beta\gamma H(\bar{\tau})}\left[\frac{E_t\pi(\tau'|\tau' \leq \bar{\tau})}{1-\beta+\beta\gamma} + \frac{\beta\gamma}{1-\beta}\frac{E_t\pi(\tau')}{1-\beta+\beta\gamma} - f_{hij}^{PRF}\right] \quad (6)$$

To find the productivity cut-off above which the firm will chose the PRF regime under uncertainty (call this regime UPRF), set the difference in present values equal to the difference in sunk costs $V_{hijt}^{PRF} - V_{hijt}^{MFN} = f_{hij}^{PRF} + f_{hij} - f_{hij}$ and solve for productivity to get the cut-off under the UPRF regime φ_{hijt}^{UPRF}:

$$\begin{aligned}\varphi_{hijt}^{UPRF} &= \left[\frac{f_{hij}\,(1-\beta)}{A_{ijt}\left(\tau_{hjt}^{MFN}\right)^{-\sigma}}\right]^{\frac{1}{\sigma-1}}\left[\frac{f_{hij}^{PRF}/f_{hij}}{\left(\tau_{hjt}^{MFN}/\tau_{hijt}^{PRF}\right)^{\sigma}-1}\right]^{\frac{1}{\sigma-1}}\left[\frac{1-\beta+\beta\gamma}{1-\beta+\beta\gamma\omega_{hijt}^{PRF}}\right]^{\frac{1}{\sigma-1}} \\ &= \underbrace{\varphi_{hijt}^{MFN}\times F_{hijt}}_{\text{PRF without uncertaity}} \times \underbrace{U_{hijt}}_{\text{uncertainty}} \quad (7)\end{aligned}$$

with

$$\omega_{hijt}^{PRF} = \frac{H(\bar{\tau})\left(\tau_{hijt}^{PRF}\right)^{-\sigma} - \left(\tau_{hjt}^{MFN}\right)^{-\sigma} + (1-H(\bar{\tau}))\,E_t\left(\tau^{-\sigma}|\tau' > \tau_{hijt}^{PRF}\right)}{\left(\tau_{hijt}^{PRF}\right)^{-\sigma} - \left(\tau_{hjt}^{MFN}\right)^{-\sigma}} < 1 \quad (8)$$

where I replaced $\bar{\tau} = \tau_{hijt}^{PRF}$. As noted in Handley and Limão (2015), this substitution involves asking what is the productivity cut-off φ^{UPRF} above which a firm would enter the PRF regime given the current PRF tariff rate, which is the interesting empirical setting. This is essentially derived in two steps: first, I derive a productivity threshold as a function of $\bar{\tau}$ that is required for a firm to find exporting under the PRF regime profitable. Second, by setting $\bar{\tau} = \tau_t^{PRF}$, I show that uncertainty pushes the productivity threshold for the PRF regime up, so that exporting preferentially becomes less attractive. The inequality in (8) follows from the fact that $E_t\left(\tau^{-\sigma}|\tau' > \tau_{hijt}^{PRF}\right) < \left(\tau_{hijt}^{PRF}\right)^{-\sigma}$.

When setting the model to query the data, the idea is the following. $\bar{\tau}$ can vary across firms depending on their productivity, and there are some firms for which the current PRF tariff rate is the $\bar{\tau}$. This is also the no-uncertainty threshold that splits firms into the MFN and PRF regimes. Note that firms with a $\bar{\tau}$ below the current PRF tariff start exporting under MFN anyway, and a threat to remove preferences will not affect their entry regime decision. Then the question is: what firms will enter the PRF regime at the current preferential tariff, and what happens if the preferential tariff can change in the future?

The key result that $\omega_{hijt}^{PRF} < 1$ implies that $U_{hijt} > 1$ and therefore that the PRF cut-off under uncertainty φ^{UPRF} is larger than the deterministic one, shifted to the right by U_{hijt}. Note that in case of no uncertainty ($\gamma = 0$) we have $U_{hijt} = 1$ and therefore the PRF entry cut-off is just the deterministic one.

Moreover, in the scenario in which the expected higher tariff is the MFN one such that $E_t\left(\tau^{-\sigma}|\tau' > \tau_t\right) = \left(\tau_{hjt}^{MFN}\right)^{-\sigma}$, the term ω_{hijt}^{PRF} collapses to $H(\bar{\tau})$, which does not depend on trade costs. In this particular case, the proportional shift in the PRF cut-off *does not* depend on the PRF/MFN tariff margin. This is because the tariff margin is exactly the same as that which the firm considers at time t in taking the decision between the preferential and MFN regimes, hence this information is already incorporated in the deterministic cut-off. This scenario has consequences for empirical applications: at the extensive margin, the proportional effect of policy uncertainty on entry is predicted to be the same across all products.

2.2.1 Export value of new firms

We can find the value of exports of firms entering in period t by integrating firm sales over productivity. In the deterministic scenario we would add up exports under the MFN regime, which are exports of firms with productivity in between φ_{hijt}^{MFN} and φ_{hijt}^{PRF}, and exports under the preferential regime (exported by firms with productivity above φ_{hijt}^{PRF}):

$$X_{hijt} = \underbrace{\int_{\varphi_{hijt}^{MFN}}^{\varphi_{hijt}^{PRF}} \pi_{hijt}^{MFN} dG(\varphi)}_{\text{MFN regime}} + \underbrace{\int_{\varphi_{hijt}^{PRF}}^{\infty} \pi_{hijt}^{PRF} dG(\varphi)}_{\text{PRF regime}} \tag{9}$$

To understand what happens to total exports by new firms under uncertainty, it is good to decompose the equations into three components: exports of new firms which trade under MFN regime both with and without uncertainty (always MFN); exports of new firms that would have traded under the PRF regime without uncertainty but choose to MFN with uncertainty (switchers); and new firms which choose the PRF regime both with and without uncertainty (always PRF). Total exports under uncertainty can written as:

$$X_{hijt} = \underbrace{\int_{\varphi^{MFN}_{hijt}}^{\varphi^{PRF}_{hijt}} \pi^{MFN}_{hijt} dG(\varphi)}_{\text{always MFN}} + \underbrace{\int_{\varphi^{PRF}_{hijt}}^{\varphi^{UPRF}_{hijt}} \pi^{MFN}_{hijt} dG(\varphi)}_{\text{switchers}} + \underbrace{\int_{\varphi^{UPRF}_{hijt}}^{\infty} \pi^{PRF}_{hijt} dG(\varphi)}_{\text{always PRF}} \quad (10)$$

For the always MFN exporters, uncertainty has no effect. These firms are not productive enough to consider preferences ($\varphi < \varphi^{PRF}_{hijt}$), so they do not care if preferences are uncertain. They face the MFN tariff both with and without uncertainty, so there is no change in their export value holding other aggregate demand and supply factors constant.[6]

At the other end of the distribution, we have firms which are very productive and therefore have large volumes of sales. The large sales volume means that they can cover the higher sunk costs of the PRF regime in a short time, hence they keep choosing the preferential regime even under uncertainty. These firms face the PRF tariff both with and without uncertainty. In between these two groups lay 'switchers' firms. These are firms which in the absence of uncertainty would trade under the PRF regime. However, when preferences become uncertain, they choose the MFN regime. Hence while without uncertainty they would face the PRF tariff, they pay the MFN one with uncertainty. Their export sales are reduced, and the reduction depends on the PRF/MFN tariff margin.

Compared to the HL model, the mechanism affecting export value is quite different. In HL firms keep facing the PRF tariff under uncertainty, and the PRF/MFN tariff margin plays a role only by moving the entry cut-off. On the other hand, in this model the movement in the entry cut-off due to uncertainty can be independent of the PRF/MFN margin if the same tariff margin affects the deterministic decision between the PRF and MFN strategies. However, the tariff margin affects the export value because some exporters start facing the MFN tariff immediately as they prefer to delay entry into the PRF regime. Moreover, while the HL model predicts that fewer firms export under uncertainty, my model (combined with an unbounded productivity distribution) predicts that the total number of exporters is unchanged, but more firms will export under the MFN regime.

After having understood the mechanism at play, I can now parametrise the productivity distribution and derive a gravity-like equation. As customary in the gravity literature, I assume an untruncated Pareto distribution of firms productivity with CDF $G(\varphi) = 1 - \varphi^{-\alpha}$. In the Appendix I show that total exports of new entrants X^{new}_{hijt} in period t, which is the sum of MFN and PRF exports $X^{new}_{hijt} = X^{new,MFN}_{hijt} + X^{new,PRF}_{hijt}$ can be written as:

$$X^{new}_{hijt} = B_{jt}^{\frac{\alpha}{\sigma-1}} C_{hij} m_{it} \left(\tau^{MFN}_{hjt}\right)^{-\frac{\alpha\sigma}{\sigma-1}} \left[1 + \left(\left(\frac{\tau^{MFN}_{hjt}}{\tau^{PRF}_{hijt}}\right)^{\sigma} - 1\right) \left(F_{hijt} \times U_{hijt}\right)^{-\alpha+\sigma-1}\right] \quad (11)$$

[6] As uncertainty affects the price index, there is an aggregate change in exports of the 'always MFN' firms. However, this price index effect common also to the 'switchers' and 'always PRF' groups, hence we consider it an aggregate demand shifter.

where $B_{jt} = Y_{jt} P_{jt}^{\sigma-1}$ summarises constant terms and market conditions in the importing country j, $C_{hij} = \frac{\alpha}{\alpha-\sigma+1} \left[\mu \left(\frac{\sigma}{\sigma-1} \delta_{ij} \right)^{1-\sigma} \right]^{\frac{\alpha}{\sigma-1}} \left[f_{hij} \left(1-\beta\right) \right]^{\frac{-\alpha+\sigma-1}{\sigma-1}}$ summarises time invariant barriers to trade and m_{it} accounts for supply side conditions in exporting country i. This is a modified gravity equation that accounts for the fixed costs of using preferences and uncertainty about preferential tariffs. Compared to the standard gravity model, equation (11) is not log-linear in tariffs. This equation nests the deterministic exports equation which arises when $U_{hijt} = 1$.

2.2.2 Exports value observed in the data

In any multi-period model with both extensive and intensive margins such as Melitz-based gravity equations, the effect of a negative shock on trade will build up over time because of the presence of legacy firms. Consider a firm with productivity just above the PRF threshold which starts exporting in period $t-1$. If conditions worsen in period t such that if it was to start in period t it would do so under the MFN regime, and the firm is still active in t, it will keep trading under the PRF regime. This implies that the extensive margin adjustment to a negative shock takes time to be fully reflected in the value of trade. Considering this issue is important for the estimation of uncertainty effects that worsen export conditions.

The previous section described exports of firms entering in period t, that is exports of new firms. In product-level trade datasets, however, we do not observe trade by new firms only, but also trade of firms that entered in the past and survived.

To understand the role played by legacy firms in the data, the first step is to separate trade into intensive and extensive margins. Past economic conditions play a role only via lagged entry as they determine the entry cut-off of legacy firms, but do not affect the intensive margin. Current economic conditions affect the extensive margin of new entrants as well as the intensive margin of both new entrants and legacy firms. Total product-level trade observed in period t can be written as:

$$X_{hijt} = \underbrace{INT_{hijt}}_{\text{intensive margin}} \times \underbrace{\left[\underbrace{EXT_{hijt}\left(\varphi^{*}_{hijt}\right)}_{\text{new exporters}} + \underbrace{\sum_{l=1}^{\infty} \left(1-\psi\right)^{l} EXT_{hijt-l}\left(\varphi^{*}_{hijt-l}\right)}_{\text{legacy firms}} \right]}_{\text{extensive margin}} \tag{12}$$

The term INT_{hijt} in equation (12) summarises aggregate demand condition in the importing country and the current MFN and PRF tariff rates which together determine the intensive margin of exports. The term in brackets is the extensive margin, which is composed of new exporters entering in period t and legacy firms. These are firms that entered in period $t-l$, where l stands for 'lag', and survived the exogenous exit shock ψ. The term $(1-\psi)^l$ is the survival rate after l periods. The extensive margin depends on the productivity cut-off φ^*_{hijt-l} at the time of entry. Note that in this model uncertainty affects trade by shifting the productivity cut-off of the PRF regime, hence its effect enters via the extensive margin of the PRF regime.

The extensive margin component in equation (12) consists of the number of exporting firms m_{it-l} in period $t-l$ and their average productivity $\int_{a_{t-l}}^{b_{t-l}} \varphi^{\sigma-1} dG(\varphi)$ which is determined by the entry cut-offs a_{t-l} and b_{t-l} at time $t-l$. Assuming an unbounded productivity distribution, for the PRF regime the two cut-offs are $a_{t-l} = \varphi^{UPRF}_{t-l}$ and $b_{t-l} = \infty$. For the MFN strategy the average productivity is computed for firms with productivity in between the MFN cut-off φ^{MFN}_{t-l} and the PRF one φ^{UPRF}_{t-l}. Plugging in the model variables and separating exports between the MFN and PRF regime in equation (12) we can write:

$$X_{hijt} = \underbrace{A_{ijt}\left(\tau^{MFN}_{hjt}\right)^{-\sigma}}_{\text{intensive margin MFN}} \times \underbrace{\left[\sum_{l=0}^{\infty} (1-\psi)^l \, m_{it-l} \int_{\varphi^{MFN}_{hijt-l}}^{\varphi^{UPRF}_{hijt-l}} \varphi^{\sigma-1} dG(\varphi)\right]}_{\text{extensive margin MFN}} + \underbrace{A_{ijt}\left(\tau^{PRF}_{hijt}\right)^{-\sigma}}_{\text{intensive margin PRF}} \times \underbrace{\left[\sum_{l=0}^{\infty} (1-\psi)^l \, m_{it-l} \int_{\varphi^{UPRF}_{hijt-l}}^{\infty} \varphi^{\sigma-1} dG(\varphi)\right]}_{\text{extensive margin PRF}} \quad (13)$$

where A_{ijt} represents aggregate conditions (among which expenditure and price index) at time t, determining the value of the intensive margin together with the tariff rate. The terms in brackets represent the extensive margins of the MFN and PRF regimes, both of new firms (with $l=0$) and legacy firms (for $l>0$). In the next section I show how we can derive an empirical equation that takes into account the presence of legacy firms in trade data and describe in details the empirical approach.

3 Empirical approach

In this section I describe the empirical approach. First, I show how we can bring the theoretical model to the data. This is done taking a log-linear approximation of equation (13) around a steady state equilibrium with no uncertainty. Second, I introduce the dataset and the variation used to identify uncertainty and Continuity Agreement effects. I then present the empirical equation and introduce a Wald test for nested models to test whether the data support the restriction of full preference utilisation imposed by the HL model.

3.1 Taking the model to the data

I derive the empirical equation by taking a log-linear approximation of (13) of all time-varying quantities around a steady state equilibrium $t = 0$ with no uncertainty ($\gamma = 0$). Details of the derivation are confined to the Appendix. This yields the following modified gravity equation:

$$
\begin{aligned}
\ln X_{hijt|t=0,\gamma=0} = \ln C_{hij} + \frac{\alpha-\sigma+1}{\sigma-1}\psi\sum_{l=0}^{\infty}(1-\psi)^l \ln\left(\frac{B_{jt-l}}{B_{j0}}\right) + \psi\sum_{l=0}^{\infty}(1-\psi)^l \ln\left(\frac{m_{it-l}}{m_{i0}}\right) + \\
-\sigma(1-\psi)\ln\left(\frac{\tau_{hjt}^{MFN}}{\tau_{hj0}^{MFN}}\right) - \frac{\alpha\sigma}{\sigma-1}\psi\left[s_{hij0}^{MFN}\ln\left(\frac{\tau_{hjt}^{MFN}}{\tau_{hj0}^{MFN}}\right) + s_{hij0}^{PRF}\ln\left(\frac{\tau_{hijt}^{PRF}}{\tau_{hij0}^{PRF}}\right)\right] \\
-\sigma\frac{\alpha-\sigma+1}{\sigma-1}\psi\sum_{l=1}^{\infty}(1-\psi)^l\left[s_{hij0}^{MFN}\ln\left(\frac{\tau_{hjt-l}^{MFN}}{\tau_{hj0}^{MFN}}\right) + s_{hij0}^{PRF}\ln\left(\frac{\tau_{hijt-l}^{PRF}}{\tau_{hij0}^{PRF}}\right)\right] + \\
-\frac{\alpha-\sigma+1}{\sigma-1}\psi\frac{\beta}{1-\beta}(1-\lambda)s_{hij0}^{PRF}\left[1-\left(\frac{\tau_{hij0}^{PRF}}{\tau_{hj0}^{MFN}}\right)^{\sigma}\right]\sum_{l=0}^{\infty}(1-\psi)^l\gamma_{t-l} \qquad (14)
\end{aligned}
$$

where C_{hij}, B_{jt} and m_{it} and their lags summarise aggregate conditions at the importer-exporter-product, importer-time and exporter time level, respectively. s_{hij0}^{PRF} is the equilibrium (pre-uncertainty) share of PRF trade and $s_{hij0}^{MFN} = 1 - s_{hij0}^{PRF}$ is the MFN share. This modified gravity equation shows that for PTA countries the applied tariff should be calculated as the geometric weighted average of the MFN and PRF tariff, with weights given by the PRF import share. This appears in logs in equation (14) as an arithmetic weighted average of the logs of tariffs (lines 2-3). The equation also augments the standard gravity equation with lags of the applied tariff (line 3).

Equation (14) is the starting point for the empirical equation. After subsuming parts into fixed effects, and dropping the importer fixed effect j given that the UK will be the only importer in the dataset, we can write:

$$
\begin{aligned}
\ln X_{hit} = & \underbrace{a_{hi} + a_{it}}_{\text{fixed effects}} \underbrace{-\sigma\left(1-\psi\right)}_{\text{coefficient}} \underbrace{\ln \tau_{hjt}^{MFN}}_{\text{MFN tariff}} + \\
& - \underbrace{\frac{\alpha\sigma}{\sigma-1}\psi}_{\text{coefficient}} \times \underbrace{\left[s_{hi}^{MFN} \ln \tau_{ht}^{MFN} + s_{hi}^{PRF} \ln \tau_{hit}^{PRF}\right]}_{\text{current applied average tariff}} + \\
& - \sum_{l=1}^{\infty} \underbrace{\sigma \frac{\alpha-\sigma+1}{\sigma-1} \psi \left(1-\psi\right)^{l}}_{\text{coefficient}} \times \underbrace{\left[s_{hi}^{MFN} \ln \tau_{ht-l}^{MFN} + s_{hi}^{PRF} \ln \tau_{hit-l}^{PRF}\right]}_{\text{lagged applied average tariff}} + \\
& - \underbrace{\frac{\alpha-\sigma+1}{\sigma-1} \frac{\psi\beta}{1-\beta} \left(1-\lambda\right) \left[\sum_{l=0}^{\infty} \left(1-\psi\right)^{l} \gamma_{t-l}\right]}_{\text{coefficient}} \times \underbrace{\left(s_{hi}^{PRF} \times \omega_{hi}\right)}_{\text{uncertainty measure}}
\end{aligned}
\tag{15}
$$

The first line summarises aggregate conditions at the product-by-partner (a_{hi}) and partner-by-time (a_{it}) level. The second line is the effect of current applied tariffs on trade, which is computed as a weighted average of the log of MFN and PRF tariff, with weights given by the MFN and PRF import shares in the base period. The third line is the effect of lagged applied tariffs on trade.

The last line is the uncertainty effect, with $\omega_{hi} = 1 - \left(\tau_{hi}^{PRF}/\tau_{h}^{MFN}\right)^{\sigma}$ being the tail risk, which measures the potential profit loss in the HL model. This is different from expression (8) which refers to the PRF model. Uncertainty effects manifest themselves over time on aggregate trade because of the presence of legacy firms, as we can see from the term $\sum_{l=0}^{\infty} \left(1-\psi\right)^{l} \gamma_{t-l}$ in the last line summarising the (discounted) history of uncertainty shocks.

In equation (15) I separate the model components into observable variables and coefficients to be estimated. For the estimation of uncertainty effects, note that the measurable part of the last line in (15) is $\left(s_{hi}^{PRF} \times \omega_{hi}\right)$, the share of PRF trade multiplied by the tariff margin. The estimated coefficient would then be $-\frac{\alpha-\sigma+1}{\sigma-1} \frac{\psi\beta(1-\lambda)}{1-\beta} \left[\sum_{l=0}^{\infty} \left(1-\psi\right)^{l} \gamma_{t-l}\right]$, which is not the same for each uncertain period but depends on when the first uncertainty news arrived, even if uncertainty news are the same for all uncertain periods. This is because of legacy firms. In the first period of uncertainty, only exports of new exporters are affected. In the second period, both the exports of new and surviving firms that entered the period before are affected. As time passes, more and more waves of new firms responded to uncertainty. At the same time, some of these new firms will have exited hence the history of uncertainty is discounted by the exit probability ψ.

Writing equation (15) with the bs representing parameters to be estimated we have:

$$\ln X_{hit} = a_{hi} + a_{it} + b^{MFN} \ln \tau^{MFN}_{hjt} + \sum_{l=0}^{\infty} b^{\tau}_{l} \left[s^{MFN}_{hi} \ln \tau^{MFN}_{ht-l} + s^{PRF}_{hi} \ln \tau^{PRF}_{hit-l} \right] + \sum_{t \geq T_0} b^{\gamma}_{t} \left(s^{PRF}_{hi} \times \omega_{hi} \right) \tag{16}$$

where T_0 is the first period after the uncertainty shock (more on the implementation of this below). And the HL empirical equation arises by setting $b^{MFN} = 0$ and $s^{PRF}_{hi} = 1$ (and therefore $s^{MFN}_{hi} = 0$) in equation (16):

$$\ln X_{hit} = a_{hi} + a_{it} + \sum_{l=0}^{\infty} b^{\tau}_{l} \ln \tau^{PRF}_{hit-l} + \sum_{t > T_0} b^{\gamma}_{t} \omega_{hi} \tag{17}$$

3.2 Estimation method

For the estimation I focus on the group of UK trade partners that enjoyed preferences prior to 2015. I explicitly exclude countries that started to have preferential access to the EU after 2015. While these are important trading partners (Canada, Japan, Singapore and Vietnam), the uncertainty measures that I can construct for these countries will be endogenous. Since preference utilisation data for these countries did not exist prior to the entry into force of the PTA, these countries started to use preferences in an already uncertain regime, therefore the preference utilisation data will be endogenous.

Among the countries that had preferential access in 2015 some changed their agreement with the EU over the period 2013-19. For instance, South Africa had the Trade Development and Cooperation Agreement (TDCA) in place with the EU since 1999, but a new agreement (the Southern African Economic Partnership Agreement, or SADC EPA) entered into force in June 2016. Therefore, I consider both the full sample of all countries with some preferential access to the EU prior to 2015 and also the sub-sample of countries which did not change the type of agreement with the EU in the period 2013-19.

The dataset covers trade data between 2013 and 2019. The period 2013-15 is the base period with no uncertainty. Uncertainty is introduced by the referendum in June 2016 and in 2019 some countries see uncertainty resolved as they signed the Continuity Agreement (CA) while other continue to trade under uncertainty. Here there are two treatment effects that we wish to estimate: first, the effect of uncertainty, and second the effect of Continuity Agreement.

Uncertainty effects are estimated by comparing the trade in 2013-15 to trade in 2016-19 across products and countries with different levels of risk. To account for the effects of legacy firms, I estimate uncertainty coefficients for each month over 2016-19 – see below.

The effect of Continuity Agreements is estimated by comparing products exposed to different levels of uncertainty before and after the signature of the CA and across countries. Intuitively, if CAs removed uncertainty we should expect the difference between products exposed to uncertainty or not to vanish after the CA is signed. Here there are three levels of comparison: over time, across products with different tariff risks, and across countries that signed or not the CA. Introducing the comparison across countries allows me to control for the evolution of uncertainty effects over time netting out this variation from the estimation of CA effects.

Different countries signed Continuity Agreements in different months of 2019. As shown by Goodman-Bacon (2021), in case of treatment heterogeneity or dynamic treatment effects, staggered adoption can create identification issues. The problem is that as a country signs the CA – and therefore becomes treated – it will become a control unit for the later signatory countries for the period in which it does not change treatment status. If the CA effect is not constant over time, using already treated units as control could be problematic, and can potentially lead to a change in the sign of the treatment effect. Note that this is not an issue in case the treatment effect is a step change (no change in trend) and/or common across all units. The presence of never-treated units, as in my case, should alleviate concerns.

In order to correct for this issue in two-way fixed effects difference-in-differences (or TWFE DD) designs, alternative estimators have been proposed (e.g., see Callaway and Sant'Anna (2021) and De Chaisemartin and d'Haultfoeuille (2020)). However, Wooldridge (2021) shows that using the TWFE framework is perfectly fine as long as we let the model be flexible enough. In this paper, I adapt the approach of Wooldridge (2021) to a triple-difference estimator. In my setting, using a triple-difference allows me to track the evolution of uncertainty over time, and clean the estimation of CA effects from such evolution.

Define a cohort of signatory countries as a group of countries for which the CA was signed in the same month of 2019. For each cohort, I will identify an average treatment effect on the treated (ATT) for each month of 2019 in which they are subject to treatment. For the February cohort, this implies estimating ATTs for the months of February-December 2019. Following the potential outcome approach, the control group is defined as the set of countries not subject to treatment (CA) in the period for which the ATT is computed. Countries that did not sign a CA in 2019 are always part of the control group, while countries that signed CAs in 2019 leave the control group from the month in which they signed a CA.

To understand the identification method, consider the scheme presented in Table 1 based on the binary treatment variable for simplicity. Each sub-table entry (a_0, b_0...) represents the difference between the base period 2013-15 and 2019 for the control group (sub-table (a) for the control group) and for the treated group (sub-table (b) for a cohort of CA signatories).

The rows of each sub-table divide products into two groups: non-treated (with zero uncertainty) and treated (with uncertainty). A treated product can be a product with a positive PRF/MFN tariff margin and non-zero preference utilisation. The columns divide the months of 2019 into two periods based on the month of 2019 in which the CA was signed. For instance, if we consider the group of countries that signed the CA in March 2019, the column CA=0 refers to January-February 2019 and the column CA=1 refers to March-December 2019.

I then compute the difference between treated and untreated products for the control group in the CA period ($d_0 - b_0$) and subtract it from the same difference for the cohort of signatory countries computing $DDD = (d_1 - b_1) - (d_0 - b_0)$. Note that this is a triple difference because each entry (b_1 or d_1) are already the difference in time between the base period 2013-15 and 2019.

While I could have computed the ATT based on a difference-in-differences (that is, looking only at sub-table b), I argue that the triple difference is an important extension. Indeed, due to changes in the level of uncertainty over the months of 2019, the difference between products treated and untreated by uncertainty also changes over time. Since changes in the levels of uncertainty are mainly related to uncertainty regarding the UK-EU relations, countries that did not sign a CA are subject to the same changes in uncertainty over time and I can therefore net out that effect using the triple difference estimator.

In practice, the triple difference is computed using the continuous measure of uncertainty and including partner-by-product-by-calendar month, partner-by-time and product-by-time fixed effects. Given the use of partner-by-product-by-calendar month fixed effects, the estimation exercise involves the comparison of the slope in the dimension of the uncertainty measure in each month over 2016-19 relative to the slope in the calendar month average 2013-15 (e.g., the average slope of January 2013-15).

Importantly for identification, the sample has never-treated units both in terms of uncertainty effects and CA effects. For uncertainty, the never-treated units are the country-product observations with zero tariff margin. This can arise because of zero MFN tariff, no preferences or no preference utilisation. In terms of Continuity Agreements, the never treated units are the countries that did not sign a CA in the sample period.

Table 1: CA effect identification scheme

	(a) Control group			(b) CA cohort	
products/time	CA=0	CA=1		CA=0	CA=1
non-treated	a_0	b_0		a_1	b_1
treated	c_0	d_0		c_1	d_1
Δproducts	$c_0 - a_0$	$d_0 - b_0$		$c_1 - a_1$	$d_1 - b_1$

3.3 The empirical equation

The empirical equation starts from (16) and accounts for the effect of Continuity Agreements. The fact that uncertainty effects build up over time means that we cannot estimate a single time-invariant coefficient for uncertainty. I can deal with this either by trying to measure the probability of an event over time and accounting for lags of uncertainty effects as done in Graziano, Handley and Limão (2021), who used betting markets odds data, or by estimating time-specific uncertainty coefficients. When estimating uncertainty effects for a long time period, it is difficult to find good proxies for uncertainty news, hence the estimation of time-specific coefficients is more appealing. Nonetheless, I provide a robustness test using an index of Brexit uncertainty over time in a specification that mimics Graziano, Handley and Limão (2021) – see section 5.3.2.

In the empirical setting, the 2016 referendum is the origin of uncertainty which divides time into a pre- and post-treatment period. If there was no uncertainty before the referendum, then the γ_t prior to the referendum would be zero. Then the uncertainty coefficient estimated for the first uncertainty period, call this T_0, depends on γ_{T_0} and not on past values of γ_t as $\gamma_{t<T_0} = 0$. On the other hand, uncertainty coefficients for periods $t > T_0$ will measure both current and the discounted series of past uncertainty shocks.

I maintain some flexibility around the referendum date and let the uncertainty period begin in January 2016 (and I also estimate an event-study regression). I interact the uncertainty measure $s_{hi}^{PRF} \times \omega_{hi}$ with time dummies a_t for each period between January 2016 and December 2019. I also include product-by-partner-by-calendar month fixed effects $a_{hi,month}$ to account for the seasonality of monthly data, and product-by-time fixed effects a_{ht} to absorb any supply and demand shock at this level. The empirical equation is then:

$$\begin{aligned} \ln X_{hit} = a_{hi,month} + a_{it} + a_{ht} + \\ \sum_{l=0}^{3} b_l^{\tau} \overline{\ln \tau_{hit-l}} + \sum_{t=Jan2016}^{Dec2019} b_t^{\gamma} \left(s_{hi}^{PRF} \times \omega_{hi} \times a_t \right) + \\ \sum_{c} \sum_{t \geq t_{CA}} b_{c,t}^{CA} \left(CA_{ct} \times a_t \times \omega_{hi} \times s_{hi}^{PRF} \right) + e_{hit} \end{aligned} \tag{18}$$

where $\overline{\ln \tau_{hit-l}} = \left[\left(1 - s_{hi}^{PRF} \right) \ln \tau_{ht-l}^{MFN} + s_{hi}^{PRF} \ln \tau_{hit-l}^{PRF} \right]$ is the applied tariff. The term $\sum_{l=0}^{3} b_l^{\tau} \overline{\ln \tau_{hit-l}}$ encompasses current tariff (for $l = 0$) and lagged tariffs (for $l > 0$), so line 2 and 3 of equation (15). I include three years of lags of applied tariff. While it might be possible to include more lags, going further back in time means dealing with more changes in product classification over time which might introduce some bias. Moreover, there is only little variation in tariffs over time in the sample. Referring back to equation (15), the structural interpretation of the current tariff coefficient is $b_{l=0}^{\tau} = -\frac{\alpha\sigma}{\sigma-1}\psi$, while for the lagged values we have $b_{l\neq0}^{\tau} = -\sigma\frac{\alpha-\sigma+1}{\sigma-1}\psi \left(1 - \psi \right)^l$.

The uncertainty coefficients b_t^{γ} are estimated for each period between January 2016 and December 2019 by interacting the uncertainty measure $s_{hi}^{PRF} \times \omega_{hi}$ with time dummies a_t. Each uncertainty coefficient measures the cumulative effect of uncertainty shocks that occurred up to period t, with past shocks discounted by the survival rate $(1-\psi)$. Say that the first period of uncertainty is July 2016: then the uncertainty coefficient for July 2016 measures $b^{\gamma}_{Jul2016} = -\frac{\alpha-\sigma+1}{\sigma-1}\frac{\psi\beta(1-\lambda)}{1-\beta}\gamma_{Jul2016}$. Then the uncertainty coefficient for August 2016 measures $b^{\gamma}_{Aug2016} = -\frac{\alpha-\sigma+1}{\sigma-1}\frac{\psi\beta(1-\lambda)}{1-\beta}\left[\gamma_{Aug2016} + (1-\psi)\,\gamma_{Jul2016}\right]$, and so on for other periods.

The cohort-time effects of CA are measured by the coefficients $b^{CA}_{c,t}$ which are estimated for each cohort of CA signatory and treatment month of 2019. The dummy CA_{ct} takes the value of one if country i in cohort c signed a CA in period t and zero otherwise. The CA effects do not have a corresponding term in the structural model of equation (14) or the simplified equation (15) tailored to UK imports. These are empirical elements necessary to test the hypothesis of whether the response of imports to uncertainty changed after the signature of a Continuity Agreement.

For the HL model, the estimating equation is derived under the restriction $s^{PRF}_{hi} = 1$:

$$\begin{gathered}\ln X_{hit} = a_{hi,month} + a_{it} + a_{ht} + \\ \sum_{l=0}^{3} b^{\tau}_{l} \ln \tau^{PRF}_{hit-l} + \sum_{t=Jan2016}^{Dec2019} b^{\gamma}_{t}\left(\omega_{hi} \times a_{t}\right) + \\ \sum_{c}\sum_{t \geq t_{CA}} b^{CA}_{c,t}\left(CA_{ct} \times a_{t} \times \omega_{hi}\right) + e_{hit}\end{gathered} \tag{19}$$

The HL regression equation in (19) is nested within the regression equation of the PRF model in (18) under the restriction and $s^{PRF}_{hi} = 1$ (hence $s^{MFN}_{hi} = 0$). To test whether the restriction on full preference utilisation changes the estimation results, I introduce a Wald test for nested models.

3.4 A Wald test for nested models

The estimating equation of the HL model is *mathematically* nested within the one of the PRF model and arises by setting the share of PRF imports equal to one. However, the estimating equation of the PRF model as expressed in (18) does not nest the HL model of equation (19) *econometrically*. That is, there is no restriction on the coefficients to be estimated that collapses equation (18) into (19). The restriction is on data. However, a simple variable substitution yields an econometrically nested structure. For the purpose of model testing and leaving aside Continuity Agreements, I re-write the econometric equation of the PRF model as:

$$\begin{aligned}\ln X_{hit} = a_{hi,month} + a_{it} + a_{ht} + \\ \sum_{l=0}^{3} b_l^{\tau} \left[s_{hi}^{PRF} \ln \tau_{hit-l}^{PRF} + s_{hi}^{MFN} \ln \tau_{ht-l}^{MFN} \right] + \\ \sum_{t=2016}^{2019} b_t^{\gamma} \left(\omega_{hi} \times s_{hi}^{PRF} \times a_t \right) + e_{hit}\end{aligned} \tag{20}$$

To simplify, exclude the effects of Continuity Agreements and I consider the interaction of the uncertainty measure with year dummies for 2016-19 rather than dummies for each year-month between Jan16-Dec19.[7]

That said, the share of preferential imports s_{hi}^{PRF} can be rewritten as one minus the share of MFN imports. Substituting $s_{hi}^{PRF} = 1 - s_{hi}^{MFN}$ in (20) and re-arranging we have:

$$\begin{aligned}\ln X_{hit} = a_{hi,month} + a_{it} + a_{ht} + \\ \underbrace{\sum_{l=0}^{3} b_l^{\tau^{PRF}} \ln \tau_{hit-l}^{PRF} + \sum_{t=2016}^{2019} b_t^{\gamma,HL} \left(\omega_{hi} \times a_t \right)}_{\text{HL model}} + \\ \sum_{l=0}^{3} b_l^{\tau} \left[s_{hi}^{MFN} \times \ln \left(\tau_{ht-l}^{MFN} / \tau_{hit-l}^{PRF} \right) \right] + \\ - \sum_{t=2016}^{2019} b_t^{\gamma,PRF} \left(\omega_{hi} \times s_{hi}^{MFN} \times a_t \right) + e_{hit}\end{aligned} \tag{21}$$

With this simple re-arrangement equation (21) now nests *econometrically* the HL model, which is represented in the second line of (21). The terms in the third and fourth lines are the additional terms of the PRF model. A Wald test on the joint significance of $b_{l=0}^{\tau}, ..., b_{l=3}^{\tau}, b_{t=2016}^{\gamma,PRF}, ..., b_{t=2019}^{\gamma,PRF} = 0$ is a test on the nested structure of the model. That is, if we reject the null hypothesis, the data reject the restriction imposed by the HL model in favour of the PRF model. Note that the re-parametrization of the model is linear, hence should not affect the properties of the Wald test. Second, the Wald test – unlike a log-likelihood ratio which assumes normality of the error term – can be performed with a cluster-robust

[7] This is to avoid reporting many coefficients which would make reading the test more difficult. However, in unreported results I checked that including interactions with year-month rather than year dummies does not affect the results of the test.

variance-covariance matrix and its test statistic is asymptotically distributed χ^2 with degrees of freedom equal to the number of restrictions tested.[8]

It should be noted that the shares of preferential and MFN imports are linearly dependent. This means that they carry the same variation, hence information for econometric estimation, and substituting s_{hi}^{PRF} for s_{hi}^{MFN} in the last line of equation (21) will only affect the *sign* of the $b_t^{\gamma,PRF}$ coefficients, which will remain the same in absolute value. Note moreover that the values of the $b_t^{\gamma,HL}$ coefficients will change as well, but only because their interpretation changes.[9] To be in line with the rest of the analysis which is carried out in terms of the share of preferential imports, I perform the Wald test on the following regression model:

$$\begin{aligned}\ln X_{hit} = {} & a_{hi,month} + a_{it} + a_{ht} + \\ & \underbrace{\sum_{l=0}^{3} b_l^{\tau^{PRF}} \ln \tau_{hit-l}^{PRF} + \sum_{t=2016}^{2019} b_t^{\gamma,HL} \left(\omega_{hi} \times a_t\right) +}_{\text{HL model}} \\ & \sum_{l=0}^{3} b_l^{\tau} \left[s_{hi}^{MFN} \times \ln\left(\tau_{ht-l}^{MFN} / \tau_{hit-l}^{PRF}\right)\right] + \\ & \sum_{t=2016}^{2019} b_t^{\gamma,PRF} \left(\omega_{hi} \times s_{hi}^{PRF} \times a_t\right) + e_{hit} \end{aligned} \tag{22}$$

This will allow me to have an easier interpretation of coefficients in the fourth line of (22) without having to switch between MFN and PRF shares. Nonetheless, I report in the Appendix the results based on (21).

3.5 Extensions and robustness

3.5.1 Instrumental variables

In the baseline estimation I use pre-referendum data for 2013-15 to compute the PRF shares. One possible concern is that, if Brexit uncertainty already started to affect the behaviour of exporters before the referendum, the baseline PRF shares s_{hi}^{PRF} might be endogenous. In particular, they would be affected by U and they would not reflect the ratio of variable/fixed

[8] Wooldridge (2021) suggests to test restrictions by estimating the unrestricted model and performing a Wald test of joint significance with a cluster-robust variance-covariance matrix.

[9] If I interact ω_{hi} with s_{hi}^{MFN} the interpretation of the coefficients on ω_{hi} is done with reference to $s_{hi}^{MFN} = 0$, hence $s_{hi}^{PRF} = 1$. If instead the share of PRF imports is used, the opposite is true and the interpretation is done with reference to $s_{hi}^{PRF} = 0$ hence $s_{hi}^{MFN} = 1$.

cost savings of the PRF regime relative to the MFN only. Importantly, the PRF shares would not reflect the true exposure to uncertainty and they might be correlated with the error term.

I address this issue by instrumenting the PRF import share of the UK with the PRF import share of the EU27 $s^{PRF}_{hi,EU27}$. In the absence of uncertainty, the PRF shares are determined by the PRF/MFN tariff margin and the additional fixed costs necessary for compliance with PTA rules. Because the UK and the EU are part of the same trade agreements, the PRF shares of the EU are determined by the same variables as UK's share, and since PTA partners' trade with the EU was not subject to Brexit uncertainty, the PRF shares of the EU are uncorrelated with U. Therefore, the EU's PRF share can serve as an instrument for UK's PRF shares. I find that the correlation between the UK's and EU27's PRF import share across partners and CN8 products is 0.70 in the period 2013-15. To maximise coverage, I use EU27 data for the period 2013-19. To further extend the coverage, I also compute the PRF share for the UK over the entire period 2013-19, and instrument the average 2013-19 UK's shares with the average 2013-19 EU27's share.

A second potential identification threat concerns the PRF/MFN ratio in ω which might suffer from measurement error. This issue was recognised by Graziano, Handley and Limão (2021). After leaving the EU, the UK would have set its own MFN tariff schedule. It can be argued that, given that the UK was part of the EU and contributed to the determination of the EU MFN tariffs, a future UK MFN tariff schedule would have been very similar to the EU's one. However, there might have been some uncertainty around the new UK MFN tariff schedule, and ω might have measurement error. I follow the approach of Graziano, Handley and Limão (2021) and instrument ω with the median of tail risks computed using the MFN tariffs of Australia, Canada, Japan and the US, which I call ω^{IV}_{hi}. If the UK PRF tariff was higher than the MFN tariff of the other countries, we would have the issue of $\omega^{IV}_{hi} < 0$, which is inconsistent with the theory. Hence, I replace $\omega^{IV}_{hi} = 0$ when it is negative. Note that to have a consistent product classification across countries we must rely on the HS 6-digit product classification rather than CN8. This means that variation in ω^{IV}_{hi} is at the 6-digit rather than 8-digit level, although regressions are done at the 8-digit level.

3.5.2 Tracking the evolution of uncertainty over time

In this robustness test, I follow Graziano, Handley and Limão (2021) and measure the evolution of uncertainty over time using the Brexit Uncertainty Index (BUI) – see Bloom et al. (2017). The index is computed from the Decision Maker Panel, a large survey of British firms, as the proportion of firms citing Brexit as a top-3 source of uncertainty. The regression model that uses the log of the BUI to track uncertainty over time is:

$$
\begin{aligned}
\ln X_{hit} = a_{hi,month} + a_{it} + a_{ht} + \\
\sum_{l=0}^{3} b_l^{\tau} \overline{\ln \tau_{hit-l}} + \sum_{l=0}^{L} b_l^{\gamma} \left(\ln BUI_{t-l} \times s_{hi}^{PRF} \times \omega_{hi} \right) + \\
\sum_{l=0}^{L} b_l^{CA} \left(\ln BUI_{t-l} \times s_{hi}^{PRF} \times \omega_{hi} \times CA_{it} \right) + e_{hit} \quad (23)
\end{aligned}
$$

I consider the current and up to two lags of the BUI, and compute the long-run elasticity to uncertainty as the sum of the coefficients b_l^{γ}. To account for zeros in the BUI, I take the hyperbolic sine transformation $\ln(x + (1 + x^2)^{1/2})$. For the Continuity Agreements, I interact the uncertainty measure with the dummy CA_{it} that takes a value of one if country i signed the continuity agreement in period t, for period t onwards. For the HL model, equation (23) is estimated setting $s_{hi}^{PRF} = 1$.

3.5.3 UK no-deal tariffs

As discussed in section 1.1, the UK Government announced a new temporary MFN tariff schedule in case of no-deal Brexit in March 2019. If exporters perceived this new schedule as credible, the measure of uncertainty based on the EU MFN tariff might be wrong. In the Appendix I show that the empirical equation can be extended to account for expectations of both an MFN and no-deal tariff risk defined as $\omega_{hij} = 1 - \left(\tau_{hi}^{PRF} / \tau_{h}^{NoDeal} \right)^{\sigma}$. Because the no-deal tariffs were introduced in March 2019, I estimate coefficients for the no-deal uncertainty and CA for the period March-December 2019. In case the UK no-deal MFN tariff is lower than the EU PRF tariff, I replace $\omega_{hi} = 0$ as uncertainty only acts via 'bad news' – this happens for about 3% of observations. The estimating equation for the PRF model is:

$$
\begin{aligned}
\ln X_{hit} = a_{hi,month} + a_{it} + a_{ht} + \sum_{l=0}^{3} b_l^{\tau} \overline{\ln \tau_{hit-l}} + \\
\sum_{t=Jan2016}^{Dec2019} b_t^{\gamma} \left(s_{hi}^{PRF} \times \omega_{hi} \times a_t \right) + \\
\sum_{t=Mar2019}^{Dec2019} b_t^{\gamma,ND} \left(s_{hi}^{PRF} \times \omega_{hi}^{NoDeal} \times a_t \right) \\
\sum_{c} \sum_{t \geq t_{CA}} b_{c,t}^{CA} \left(CA_{1,ict} \times a_t \times \omega_{hi} \times s_{hi}^{PRF} \right) + \\
\sum_{c} \sum_{t \geq t_{CA}} b_{c,t}^{CA,ND} \left(CA_{1,ict} \times a_t \times \omega_{hi}^{NoDeal} \times s_{hi}^{PRF} \right) + e_{hit}
\end{aligned}
\quad (24)
$$

and the one of the HL model is the same but with $s_{hi}^{PRF} = 1$. Testing whether the coefficients on the no-deal uncertainty $b_t^{\gamma,ND}$ are different from zero is equivalent to testing whether no-deal tariffs were perceived as credible. The idea is that the tariff distribution changes from the binary distribution considered so far to include an additional state which is the no-deal tariff scenario. This is explained in detail in the Appendix.

3.5.4 Other robustness tests

To control for possible shocks at the exporter-product level, I use as dependent variable the difference between log of UK imports and log of EU27 imports from the PTA partner countries in the regression equation: $\ln X_{hit,GB} - \ln X_{hit,EU27}$.

The concordance of products over time implies aggregating some product codes that split and merge across different classifications. I check whether this issue affects the baseline results by dropping the products that change code over time.

The main dataset considers imports excluding processing trade. I re-estimate the baseline model including processing trade in both the dependent variable and the calculation of the PRF import shares. Overall, processing trade accounts for only a small fraction of UK imports from PTA countries.

For the Continuity Agreements I check whether moving the treatment date from the signature of the CA to the day of presentation to the UK Parliament affects results. The date of presentation to Parliament can be months after the actual signature, meaning that we would assign treatment periods to the control period if treatment actually starts with the signature of the CA.

I check whether the inclusion of product-time fixed effects, which restricts the variation used for the estimation, alters the econometric results significantly. Finally, given that Graziano, Handley and Limão (2021) (GHL) present the only other available estimates of Brexit uncertainty effects on UK imports from PTA partners, I estimate a specification similar to GHL on the same sample of PTA countries to see if results differ.[10] Given that GHL tracks the evolution of uncertainty over time, I use model (23) where I interact the MFN risk measure with the log of the Brexit Uncertainty Index.

4 Data

The empirical analysis requires data on (i) preference utilisation rates; (ii) monthly trade flows at the product level; (iii) MFN tariff rates; and (iv) preferential tariff rates. This dataset is supplemented with information about PTAs and Continuity Agreements. Data for UK and EU27 imports and preference utilisation are taken from the Eurostat Comext database. Information on MFN and preferential tariffs is taken from the ITC MacMap database. Information on PTAs and Continuity Agreements is taken from the European Union Commission and the UK Government websites, respectively. A more detailed description of the data is reported in the Appendix.

The dataset includes all EU PTA partners which enjoyed preferential access in 2015 to the EU and that now have a trade agreement in place with the EU.[11] Some of these countries had preferential access to the EU before 2016 under the GSP or EBA schemes, and signed a trade agreement only after 2015, while other countries such as South Africa changed the type of agreement in the period 2015-19. Therefore, I consider both the full sample, which counts 70 countries, and the restricted sample of countries with PTAs in place before 2013 and that did not change agreement in the period 2013-19. This restricted sample counts 41 countries. A full list of PTA partners is reported in Tables 8-9 in the Appendix.

In the main analysis I exclude imports for inward and outward processing (codes 2 and 3 of the Eurostat Comext statistical regime). These flows concern processing trade and products imported under these regimes are fully or partially exempt from customs duties. Since no duty is levied on these flows, they are not subject to tariff uncertainty. In the sample, processing trade accounts for 3.6% of total imports in 2015. As a robustness test, I also check whether including processing trade alters the results.

The baseline PRF shares are computed with data for 2013-15. Using data for 2013-15 means that if a partner-product observation was not traded in 2013-15 but it was traded in 2016-19 it drops from the sample. This implies dropping around 6% of observations from the dataset when

[10] The sample of GHL includes Iceland, Norway, Switzerland, Turkey, Mexico, Israel, Chile and South Korea.

[11] Of the current EU PTA partners, I exclude Canada, Japan, Singapore and Vietnam as they signed trade agreements with the EU after 2015.

processing imports are excluded and 5% when both processing and non-processing imports are considered. As a robustness test, I compute PRF shares for the entire period 2013-19 and instrument them with the EU27 shares for the same period.

Table 2 reports the summary statistics of the log of imports (excluding processing trade), PRF and applied tariff rates, and for the other independent variables at the reference period 2013-15. The average share of PRF imports in 2013-15 excluding processing trade is 0.52 for the UK and 0.54 for the EU27. Excluding the observations with zero MFN tariff, for which the PRF share is zero, the average 2013-15 PRF share is 0.67 for the UK and 0.71 for the EU27. A cross-section regression of the PRF share s_{hi}^{PRF} on the PRF and MFN tariffs yields a positive coefficient for the MFN tariff and a negative one for the PRF tariff, as expected.[12]

Table 2: Summary statistics for UK imports ex. processing trade

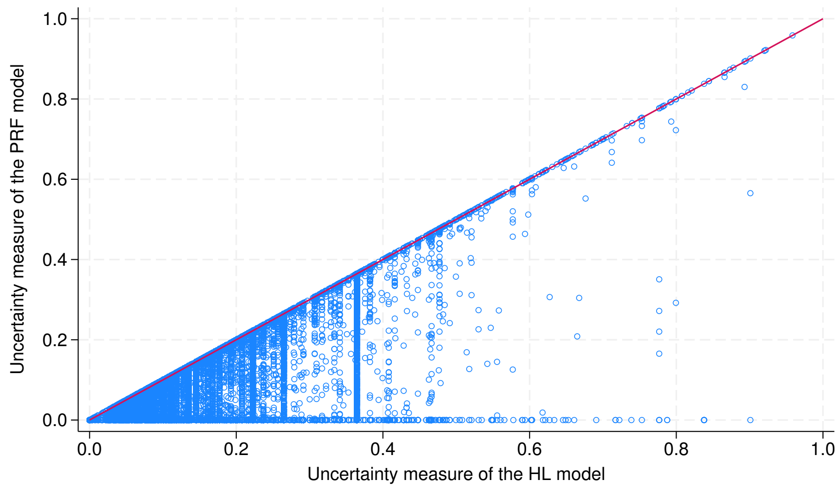
	Mean	sd	Median	Min	Max	Count
Log UK imports ($\ln X_{hit,UK}$)	10.018	2.010	9.848	0.000	22.278	849,407
Log EU imports ($\ln X_{hit,EU}$)	11.750	2.776	12.052	0.000	21.444	728,516
Log preferential tariff ($\ln \tau_{hit}^{PRF}$)	0.002	0.020	0.000	0.000	0.776	845,350
Log applied tariff ($\ln \overline{\tau_{hit}}$)	0.012	0.029	0.001	0.000	0.776	794,306
PRF share UK 2013-15 ($s_{hi,UK}^{PRF}$)	0.522	0.449	0.668	0.000	1.000	805,064
PRF share UK 2013-19 ($s_{hi,UK}^{PRF}$)	0.509	0.439	0.599	0.000	1.000	849,335
PRF share EU 2013-19 ($s_{hi,EU}^{PRF}$)	0.540	0.419	0.718	0.000	1.000	837,793
Potential profit loss (ω_{hi})	0.145	0.138	0.101	0.000	0.975	837,683
Potential profit loss IV (ω_{hi}^{IV})	0.097	0.108	0.060	0.000	0.558	845,020
MFN risk $= s_{hi,UK}^{PRF} \times \omega_{hi}$	0.110	0.135	0.060	0.000	0.958	794,316
log Brexit Uncertainty Index	0.245	0.204	0.346	0.000	0.548	849,407

The uncertainty measures of the two models ω_{hi} and $\omega_{hi} \times s_{hi}^{PRF}$ should be correlated, as they are both functions of the PRF/MFN margin. Indeed the correlation between the two measures is 0.73 for the observations with non-zero preferential margin. However, out of 39,029 partner-CN8 cross-sectional observations for which I have data on both s_{hi}^{PRF} and ω_{hi} and there is a non-zero preferential margin, there are 21,006 observations for which the PRF share is zero. Figure 3 plots the uncertainty measures of the PRF and HL models against each other for each country-CN8 observation. On the diagonal y=x we have the observations for which the share of PRF trade is 1 (about 21% of the cross-sectional dimension, and 28% when excluding observations with no preferential margin), while below the diagonal there are points for which $s_{hi}^{PRF} < 1$ and on the horizontal axis lie the observations with $s_{hi}^{PRF} = 0$. The HL measure would overstate the level of uncertainty for all observations with preferential trade share strictly

[12] This is true both regressing $s_{hi}^{PRF} = b_1 \ln \tau_{hi}^{PRF} + b_2 \ln \tau_h^{MFN}$ and also including partner fixed effects.

smaller than one.

Figure 3: Comparison of uncertainty measures, UK imports



The figure plots the partner-product uncertainty measure of the PRF model against the one of the HL model. In the HL model uncertainty is defined as $\omega = 1 - (\tau^{PRF}/\tau^{MFN})^{\sigma}$ while in the PRF model this measure is multiplied by the PRF share $\omega \times s^{PRF}$.

5 Results

5.1 Wald test

Table 3 reports the results for the Wald test for nested models based on equation (22). Columns 1 and 3 report the results for the restricted model (the HL model) for comparison, while columns 2 and 4 report those for the unrestricted model. The Wald statistic on the joint significance of the additional parameters estimated in the unrestricted model together with their p-values are reported at the bottom of the table.

Table 3: Wald test

	(1)	(2)	(3)	(4)
$\ln \tau_{hit}^{PRF}$	-0.850*	-1.160*	-1.463*	-2.040**
	(0.442)	(0.624)	(0.772)	(0.924)
$\ln \tau_{hit-1}^{PRF}$	-0.639*	-0.694*	-1.433**	-1.660**
	(0.364)	(0.386)	(0.650)	(0.755)
$\ln \tau_{hit-2}^{PRF}$	-0.381	-0.486	0.235	-0.184
	(0.332)	(0.335)	(0.647)	(0.682)
$\ln \tau_{hit-3}^{PRF}$	-0.066	0.074	-0.200	-0.031
	(0.318)	(0.336)	(0.578)	(0.646)
$\omega_{hi}\times$ Year=2016	-0.027	0.322***	0.151	0.509*
	(0.052)	(0.120)	(0.227)	(0.283)
$\omega_{hi}\times$ Year=2017	-0.157**	0.507***	0.453	1.370***
	(0.063)	(0.141)	(0.292)	(0.359)
$\omega_{hi}\times$ Year=2018	-0.323***	0.421***	0.105	1.396***
	(0.070)	(0.152)	(0.352)	(0.424)
$\omega_{hi}\times$ Year=2019	-0.304***	0.659***	0.108	1.499***
	(0.077)	(0.161)	(0.438)	(0.508)
$\ln \tau_{ht}^{MFN}$		0.208		
		(0.564)		
$s_{hi}^{MFN} \times \ln(\tau_{ht}^{MFN}/\tau_{hit}^{PRF})$		-1.620		-2.506
		(1.344)		(2.302)
$s_{hi}^{MFN} \times \ln(\tau_{ht-1}^{MFN}/\tau_{hit-1}^{PRF})$		-0.280		0.051
		(0.663)		(1.945)
$s_{hi}^{MFN} \times \ln(\tau_{ht-2}^{MFN}/\tau_{hit-2}^{PRF})$		-0.467		-1.254
		(0.552)		(1.531)
$s_{hi}^{MFN} \times \ln(\tau_{ht-3}^{MFN}/\tau_{hit-3}^{PRF})$		-0.325		-0.761
		(0.560)		(1.070)
$s_{hi}^{PRF} \times \omega_{hi}\times$ Year=2016		-0.401***		-0.367**
		(0.125)		(0.172)
$s_{hi}^{PRF} \times \omega_{hi}\times$ Year=2017		-0.772***		-0.942***
		(0.146)		(0.208)
$s_{hi}^{PRF} \times \omega_{hi}\times$ Year=2018		-0.868***		-1.342***
		(0.157)		(0.222)
$s_{hi}^{PRF} \times \omega_{hi}\times$ Year=2019		-1.133***		-1.446***
		(0.168)		(0.233)
Observations	703,846	703,846	549,992	549,992
Wald		5.82		5.99
p-value		0.00		0.00

Robust s.e. clustered at partner-CN8 level. * p<0.10, ** p<0.05, *** p<0.01. Columns 1 and 3 report estimates of the HL model while columns 2 and 4 report the results for the unrestricted model. The bottom of the table reports the Wald statistic for the test of joint significance of the additional coefficients estimated in the unrestricted model. Columns 1-2 do not include CN8-time fixed effects, while columns 3-4 do include them. The Wald statistic is distrubuted χ^2 with 9 dof in column 2 and 8 dof in column 4. The uncertainty effects are estimated for each year between 2016-19.

Columns 1-2 and 3-4 differ in the fixed effects structure. Columns 1-2 include partner-CN8 product and partner-time fixed effects, while columns 3-4 also include CN8-time fixed effects. Differences in the number of observations are due to the unbalanced nature of the panel dataset and singleton observations being removed. For the PRF model, when CN8-time FEs are not included the MFN tariff rate is added as a regressor in line with the theoretical model in equation (14).

With the inclusion of CN8-time fixed effects, the variation available to estimate uncertainty effects comes from variation within CN8 products across countries in the tail risk and the share of PRF imports. This has implications for the estimation of the coefficients on the tail risk measure ω_{hi}, which change sign and become non-significant when CN8-time FE are included (compare columns 1 and 3). On the other hand, the coefficients on the interaction of the tail risk with the share of preferential imports remain similar in size and significance with and without CN8-time FE (compare columns 2 and 4). There are two possible explanations for this. One is that the response of imports to the tail risk is actually driven by aggregate product-level shocks. The second is the lack of variation in tariff margins across countries for the same CN8 product. In Table 4 I break down the within and between variation in the tail risk ω_{hi} and the share of preferential imports s_{hi}^{PRF} along the dimensions of countries and CN8 products. For the tariff margin, which drives the variation in ω_{hi}, there is much more variation between than within CN8 products. On the other hand, the share of preferential imports has a similar variation between and within CN8. Hence, CN8-time FEs likely remove much of the variation necessary to estimate the tail risk effects by itself, but at the same time their exclusion is likely to introduce some bias as product-specific shocks are not accounted for. Given that the variable of interest in this paper is the interaction of the tail risk with the share of PRF trade and that the introduction of CN8-time FE does not dramatically reduce the variation in this variable, in the rest of the paper I include CN8-time FE. I discuss results with different levels of product-time FE in section 5.3.3.

Table 4: Variation in variables across CN8 products and countries

Variation (sd)	ω_{hi}	s_{hi}^{PRF}	$\omega_{hi} \times s_{hi}^{PRF}$
Overall	0.137	0.454	0.129
Between CN8	0.139	0.366	0.120
Within CN8	0.037	0.328	0.078

But let's come to the Wald test. Whether CN8-time fixed effects are included or not, the data speak clearly. The Wald statistic is highly significant, and the restriction imposed by the standard HL model is rejected. The coefficients on the interaction of tariffs with the share of MFN trade are not significant one by one in columns 2 and 4. However, these are not the main coefficients of interest, and there is little variation in tariffs over time anyway. Differently, all coefficients on the interaction of the tail risk with the share of PRF imports are strongly significant. To summarise, the results of the Wald test tell us that when tariffs are not granted unconditionally, as in the case of a free trade agreement, if we want to estimate the effects of tariff uncertainty we must account for the share of preference utilisation as this variable carries meaningful information.

A few words should be spent on the change of sign of the coefficients on the interaction of time dummies and the tail risk between columns 1-2 and 3-4, which might appear odd at first sight. To better understand what is going on, consider the marginal effect of the tail risk in a given post-treatment year. With reference to equation (22), the marginal effect is computed as $\partial^2 \ln X_{hit}/\partial a_t \partial \omega_{hi}$ where a_t is a year dummy. When computing the marginal effect we should be careful in noting that the share of preferential (or MFN) imports and the tail risk are not two independent variables, but they are structurally linked. While the (equilibrium) share of PRF imports is a sufficient statistic when it comes to estimating the econometric model, breaking down the model to its fundamental variables we can see that s_{hi}^{PRF} is a function of the tariff margin. Apart from the theoretical set-up developed in this paper, it should be enough to think that when the tariff margin is zero, the share of preferential imports is also zero by definition. Moreover, the literature on preference utilisation often stresses how the tariff margin is a determinant of preference utilisation rates. Hence, when computing the marginal effect of ω_{hi} we must also consider its effect on s_{hi}^{PRF}. The marginal effect is:

$$\frac{\partial \ln X_{hit}}{\partial a_t \partial \omega_{hi}} = \underbrace{\tilde{b}_t^{\gamma,HL} + \tilde{b}_t^{\gamma,PRF} s_{hi}^{PRF}}_{\text{in the regression model}} + \underbrace{\tilde{b}_t^{\gamma,PRF} \left(\frac{\partial s_{hi}^{PRF}}{\partial \omega_{hi}} \omega_{hi} \right)}_{\text{not in the regression model}} \tag{25}$$

where the first two terms are estimated regression coefficients and the observed share of PRF imports, while the third term is not observed. Theory implies – and the large literature on preference utilisation finds – that the tariff margin has a positive effect on preference utilisation so that $\partial s_{hi}^{PRF}/\partial \omega_{hi} > 0$. I also find a positive correlation between these two variables in the dataset used here.[13] Given that the sign of the second and third term is the same (given by $\tilde{b}_t^{\gamma,PRF}$ which is negative according to the results of Table 3), ignoring the third term means underestimating the marginal effect of the tail risk.

Hence, if we are interested in the marginal effects of the tail risk we should be careful in accounting for its effect on the share of preferential imports.

We know for a fact that preference utilisation rates are not 100%. The econometric test carried out here tells us something more: the information contained in the preference utilisation data is not to be overlooked. This information can help us to understand the response of trade given a shock to trade costs or a change in uncertainty regarding tariff preferences. Moreover, data on preference utilisation is likely to be relevant for any analysis concerning conditional tariff

[13] Using data for 2013-15 by partner and CN8 products, the cross-sectional correlation coefficient between the share of PRF imports and the tariff margin (expressed as 1-(1+PRF)/(1+MFN)) is 0.44.

preferences, and not for uncertainty only. Given the availability of preference utilisation data, at least for large traders such as the EU and the US, it is somehow surprising that structural models of trade often ignore the conditionality of PTA tariff preferences. Ex-ante studies carried out by governments when preparing to negotiate free trade agreements might want to consider the conditionality of preferences in their analysis.

5.2 Baseline results

Table 5 reports the baseline results using both the HL and PRF models based on equations (19) and (18) respectively. In all regressions the dependent variable is the log of UK imports of CN8 products from PTA partners over the period Jan2013-Dec2019, at monthly frequency. Columns 1-2 report the results for the HL model while results for the PRF model are in columns 3-4. For the HL model the tariff rates are the preferential tariffs, while for the PRF model they are the applied tariff computed as $\ln \tau_{hit-l} = s_{hi}^{PRF} \ln \tau_{hit-l}^{PRF} + \left(1 - s_{hi}^{PRF}\right) \ln \tau_{ht-l}^{MFN}$. For all models I use the sample of countries with PTAs in place prior to 2013 which did not change agreement in due course (columns 1 and 3) and for the full sample (columns 2 and 4). The table reports the within R-squared, Akaike and Bayesian information criteria (AIC and BIC) for model fit comparison. The number of observations is slightly smaller for the PRF model due to missing values for the share of PRF trade. This happens for products that were not traded in 2013-15 as I cannot compute base-period PRF shares.

The coefficients on the current tariffs are negative and significant in all specifications. The one-year lag of the tariff is significant only for the HL model, while other lags are not significant. I also notice that for the pre-2013 PTA sample the coefficient on the current tariff is larger than the one estimated on the full sample. The general non-significance of lagged tariff terms should not be interpreted as legacy firms not being important in total trade. As explained above, the presence of legacy firms will have an effect mainly on the estimation of negative economic shocks rather than positive ones. In my sample tariff changes over time are often positive shocks (decrease in tariffs) and small (the average yearly change in the applied tariff is -0.02%).

The coefficients on the MFN risk, or uncertainty, are estimated for each period between January 2016 and December 2019. For the HL model the MFN risk is measured with the modified tariff margin $\omega = 1 - (\tau^{PRF}/\tau^{MFN})^{\sigma}$ and for the PRF model the tariff margin is multiplied by the PRF import share. For a matter of space I report year averages of the uncertainty coefficients in Table 5 and plot the individual coefficients with the 95% confidence interval in Figure 4 for the PRF model (the standard errors in Table 5 are those on the linear combination – simple average – of month-specific coefficients). The MFN risk coefficient for 2019 reported in Table 5 is computed as $12^{-1} \sum_{t=Jan19}^{Dec19} b_t^{\gamma}$, and similarly for the other years.

The estimation of CA effects is done for each cohort c and period t, but I report only the average CA effect in Table 5. This is computed as the simple average across all cohort-time coefficients: CA $= N_{CA}^{-1} \sum_c \sum_{t \geq t_{CA}} b_{c,t}^{CA}$. The disaggregated CA effects are reported in Figure 9 in the Appendix. The standard error on the average CA effect is computed as the standard error of the mean of multiple random variables.

Using the HL model, I do not find evidence of uncertainty affecting UK imports from PTA partners between Jan2016-Dec2019. In contrast, when I use the PRF model I find negative and significant effects of uncertainty in the post-referendum period which are increasing in magnitude over time. Incorporating the information contained in the PRF import shares is important for empirical analysis of uncertainty within PTAs. Without accounting for it, the measure of risk suffers from measurement error and coefficient estimates would be biased. From Table 5, we would conclude that there was no effect of uncertainty on UK imports if we ignored the PRF import share while adding this information to the analysis reverts the conclusions.

To see the evolution of uncertainty effects over time, Figure 4 plots all uncertainty coefficients of the PRF model. Panel (a) refers to the pre-2013 PTA sample (column 3 of Table 5) while panel (b) refers to the full sample (column 4 of Table 5), although differences are small. There is no evident sign of uncertainty effects before the referendum and a sudden drop in imports just in June-July 2016. From then on uncertainty effects increase with some variation over time, with a positive spike in May 2019 and another large drop in December 2019, when the UK held its General Elections.

The increase in the magnitude of uncertainty coefficients over time can be explained by two factors. First, the presence of legacy firms in the data means that the effects of uncertainty build up over time. Second, it is possible that the probability of a policy change as perceived by firms increases over time. Considering the evolution of Brexit negotiations, which did not follow a straight path, it is likely that both forces are at play in Figure 4. A detailed discussion of the events that might have led to more uncertainty in 2019 is presented in section 5.4.

For the effect of Continuity Agreements, I find that the average of the cohort-time treatment effects is positive and significant for the PRF model but negative and significant for the HL model. Examination of the disaggregated CA effects shows that the negative average CA results of the HL model are driven by a few observations for small countries: Antigua and Barbuda, the Bahamas and Kosovo. For these observations the share of PRF imports is zero, hence the PRF model assigns no uncertainty to them, and they are therefore excluded from the calculation of CA effects in the PRF model. If I exclude the cohort-time specific CA effects for these countries from the calculation of the average CA effect in the HL model, then these turn out to be similar to the one of the PRF model.

Focusing on the PRF model, the average CA effects are positive and significant, but smaller than the uncertainty effects in 2019. This provides some evidence that the CA removed only part of the uncertainty introduced by the referendum. The row 'CA+MFN risk' in Table 5 reports the test results of the hypothesis that the average CA effect plus the average uncertainty effects in 2019 over Feb-Dec equals zero. The average uncertainty effect in 2019 is computed over the period February-December as the first Continuity Agreements were signed in February 2019. The hypothesis that the sum of average uncertainty and CA effects is zero is rejected, and we can see that the CA removed about 20-30% of the referendum uncertainty.[14]

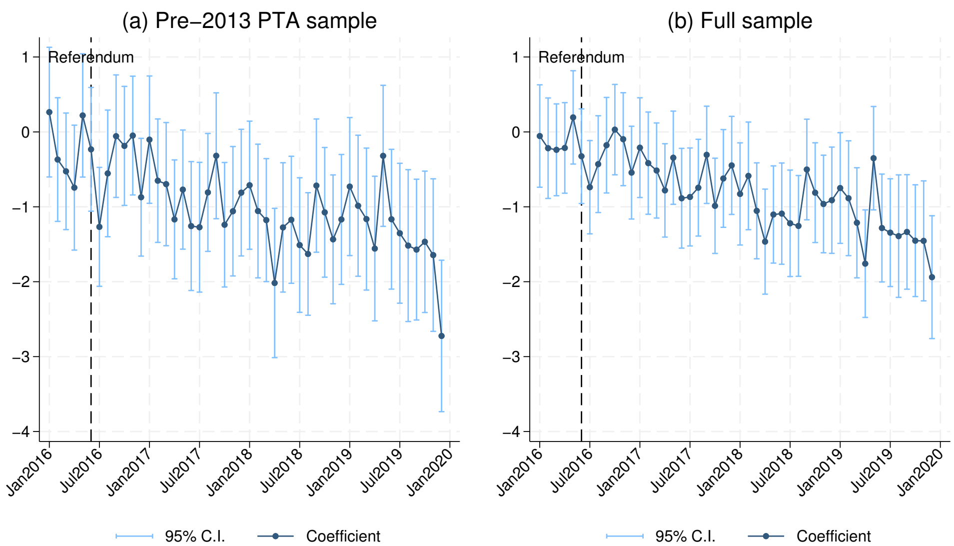
[14]This is computed dividing the average CA effect by the average uncertainty effect in Feb-Dec2019 .

Table 5: Baseline results

	HL model		PRF model	
	(1)	(2)	(3)	(4)
	pre-2013 PTAs	Full sample	pre-2013 PTAs	Full sample
Current tariff	-2.089**	-1.690**	-3.196**	-1.770*
	(1.000)	(0.765)	(1.433)	(0.978)
Lagged tariff, 1-year	-1.422*	-1.601**	-1.450	-1.156
	(0.818)	(0.630)	(1.090)	(0.739)
Lagged tariff, 2-year	0.376	0.073	0.567	0.034
	(0.861)	(0.639)	(0.976)	(0.707)
Lagged tariff, 3-year	-0.617	-0.045	-0.550	0.049
	(0.719)	(0.564)	(0.878)	(0.648)
MFN risk, mean 2016	-0.006	0.167	-0.365*	-0.235
	(0.347)	(0.225)	(0.189)	(0.144)
MFN risk, mean 2017	0.793*	0.473	-0.846***	-0.594***
	(0.426)	(0.293)	(0.225)	(0.175)
MFN risk, mean 2018	0.382	0.191	-1.245***	-0.983***
	(0.559)	(0.349)	(0.241)	(0.187)
MFN risk, mean 2019	0.980	-0.133	-1.350***	-1.263***
	(0.685)	(0.435)	(0.270)	(0.210)
Continuity Agreement	-1.009***	-0.828***	0.463**	0.334**
	(0.353)	(0.292)	(0.195)	(0.167)
CA+MFN risk	-0.100	-1.066**	-0.944***	-0.976***
	(0.736)	(0.495)	(0.288)	(0.225)
Partner-product-month FE	Yes	Yes	Yes	Yes
Partner-time FE	Yes	Yes	Yes	Yes
Product-time FE	Yes	Yes	Yes	Yes
Observations	451,130	559,300	445,367	549,992
R2-within	0.0009	0.0007	0.0015	0.0013
AIC	1068152	1330151	1056341	1310755
BIC	1069166	1331342	1057342	1311922

Robust s.e. clustered at partner-CN8 level. * p<0.10, ** p<0.05, *** p<0.01. Columns 1-2 report the estimates based on the Handley Limao model. Columns 3-4 are based on the PRF model. In columns 1-2 the tariff is log of 1 plus the preferential tariff, while in columns 3-4 it is the log weighted-average applied tariff $s^{PRF} \ln \tau^{PRF} + s^{MFN} \ln \tau^{MFN}$. The dependent variable is the log of UK imports from PTA partners excluding processing trade. MFN risk coefficients are estimated for each period between Jan2016-Dec2019, and year averages are reported. CA effects are computed for each cohort-period, and the average of all cohort-period effects is reported. For the HL model, uncertainty is measured as $\omega = 1 - (\tau^{PRF}/\tau^{MFN})^{\sigma}$ with $\sigma = 4$. For the PRF model the uncertainty measure is the one of the HL model multiplied by the PRF share $\omega \times s^{PRF}$. The term 'CA+MFN risk' tests whether the sum of the average CA and the average uncertainty effects in Feb2019-Dec2019 equal zero.

Figure 4: Uncertainty effects over time, PRF model



The figures report the coefficients and 95% confidence interval of the period-specific uncertainty effects of the PRF model based on the estimates reported in Table 5.

5.3 Robustness

5.3.1 Instrumental variable regression

I report the results for the IV estimation in Table 6. Columns 1-2 instrument the 2013-15 UK PRF share s_{hi}^{PRF} with the median PRF share of the EU27 computed over 2013-19. Columns 3-4 instrument the tail risk measure $\omega_{hi} = 1 - \left(\tau_{hi}^{PRF}/\tau_{h}^{MFN}\right)$ using the median tail risk computed with the MFN tariffs of Australia, Canada, Japan and the US. In columns 5-6 I instrument the PRF import share of the UK over 2013-19 with the EU PRF share for the same period to maximise sample coverage. Finally, in columns 7-8 I instrument both the 2013-19 UK PRF import share and the tail risk ω_{hi}.

The IV regressions involve instrumenting the interaction of many dummies with the potentially endogenous variables. Because of the large number of parameters estimated and fixed effects, statistical programs (either reghdfe in Stata or feols in R) used for the estimation failed to report the F statistic of the first stage in some instances. In the Appendix Tables 19-23 I report results for the estimation of one uncertainty effect for each year (rather than year-month) and without dealing with staggered adoption of CA (by using a single dummy for CA treatment). These reduced models do not fail in the calculation of F statistics and offer a neater way of presenting first-stage regressions.[15] Overall, the F statistics indicate that the instruments are not weak.

The coefficients on current and lagged tariffs are similar to the ones of Table 5, and when I instrument the PRF share the one-year lagged tariff is often statistically significant.

The effect of uncertainty is negative and significant in all specifications. The MFN risk coefficients are (in absolute value) slightly smaller when I instrument the PRF share and slightly larger when I instrument the tariff margin. The coefficients on the average CA effect are always positive and significant, but smaller than the 2019 uncertainty coefficients. The hypothesis that Continuity Agreements removed uncertainty is always rejected, although at conventional significance levels. However, compared to the baseline specification the CA effects are larger, lying between 34% and 60% of the uncertainty effects across the different IV regressions.

[15] For the IV regressions of Table 6, I would have to report first stages for MFN risks for each period from Jan2016 to Dec2019 and each cohort-time coefficient for the CA effects, together with the tariffs. This would imply reporting 104 first stages because of interaction with time dummies. Given that the (possibly) endogenous regressors are actually fixed in time, I report first-stage regressions for the reduced model which are easier to read.

Table 6: IV regressions

	PRF share 2013-15		Tariff margin		PRF share 2013-19		PRF shr 13-19; tariff margin	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	pre-2013 PTAs	Full sample	pre-2013 PTAs	Full sample	pre-2013 PTAs	Full sample	pre-2013 PTAs	Full sample
Current tariff	-4.256***	-2.279***	-3.044***	-1.577**	-4.319***	-2.476***	-4.148***	-1.983***
	(1.048)	(0.759)	(0.938)	(0.683)	(1.060)	(0.743)	(1.067)	(0.753)
Lagged tariff, 1-year	-2.463***	-1.574**	-1.228	-0.842	-2.481***	-1.669**	-2.083**	-1.041
	(0.954)	(0.689)	(0.859)	(0.623)	(0.952)	(0.663)	(0.957)	(0.671)
Lagged tariff, 2-year	0.485	0.358	0.674	0.158	0.448	0.263	0.549	0.430
	(0.866)	(0.622)	(0.786)	(0.544)	(0.855)	(0.595)	(0.859)	(0.600)
Lagged tariff, 3-year	-0.357	0.132	-0.803	-0.006	-0.335	0.123	-0.591	0.142
	(0.615)	(0.489)	(0.523)	(0.412)	(0.589)	(0.459)	(0.593)	(0.463)
MFN risk, mean 2016	-0.472**	-0.410**	-0.571***	-0.451***	-0.500***	-0.435***	-0.704***	-0.956***
	(0.189)	(0.161)	(0.149)	(0.122)	(0.190)	(0.160)	(0.233)	(0.214)
MFN risk, mean 2017	-0.564***	-0.420***	-1.103***	-0.875***	-0.554***	-0.425***	-1.015***	-1.024***
	(0.187)	(0.158)	(0.148)	(0.121)	(0.184)	(0.155)	(0.224)	(0.207)
MFN risk, mean 2018	-0.987***	-0.938***	-1.825***	-1.481***	-0.985***	-0.865***	-1.773***	-1.720***
	(0.187)	(0.159)	(0.150)	(0.122)	(0.185)	(0.156)	(0.226)	(0.209)
MFN risk, mean 2019	-1.133***	-1.219***	-1.737***	-1.626***	-1.154***	-1.261***	-1.647***	-1.960***
	(0.196)	(0.167)	(0.158)	(0.131)	(0.192)	(0.163)	(0.231)	(0.214)
Continuity Agreement	0.538***	0.447***	0.873***	0.592***	0.556***	0.432***	1.006***	0.845***
	(0.141)	(0.133)	(0.167)	(0.162)	(0.137)	(0.125)	(0.187)	(0.188)
CA+MFN risk	-0.646***	-0.784***	-0.928***	-1.070***	-0.648***	-0.835***	-0.663**	-1.078***
	(0.233)	(0.202)	(0.194)	(0.171)	(0.227)	(0.193)	(0.295)	(0.276)
F-stat 1st stage	1093	.	.	.	1493	.	743	.
Partner-product-month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Partner-time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product-time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	442,197	545,938	445,367	549,992	447,579	554,734	447,579	554,734
AIC	1050098	1302745	1056556	1311056	1061036	1321067	1061442	1321876
BIC	1051099	1303911	1057558	1312223	1062038	1322235	1062444	1323044

Robust s.e. clustered at partner-CN8 level. * p<0.10, ** p<0.05, *** p<0.01. The dependent variable is the log of UK imports from PTA partners excluding processing trade. In columns 1-2 I instrument the 2013-15 UK preferential imports share with the 2013-19 EU27 share. In columns 3-4 I instrument the tariff margin with the median margin computed using the MFN tariffs of Australia, Canada, Japan and the US. In columns 5-6 I instrument the 2013-19 UK preferential imports share with the 2013-19 EU27 share. In columns 7-8 I instrument both the 2013-19 PRF share and the tariff margin. The coefficients on uncertainty (MFN risk) for the years 2016-19 are simple averages of uncertainty effects in all months of each year. The CA effect is computed as simple average over all cohort-time ATEs. The term 'CA+MFN risk' tests whether the sum of the CA effects and the uncertainty in Feb-Dec2019 equal zero.

5.3.2 Tracking uncertainty over time

Table 7 reports the results for model (23), where I interact the MFN risk with the current and up to two lags of the log of the Brexit Uncertainty Index. The coefficients reported in Table 7 are the cumulative effects computed as the sum of coefficients over lags 0-2.

Table 7: Interaction with Brexit Uncertainty Index

	HL model		PRF model	
	(1)	(2)	(3)	(4)
	pre-2013 PTAs	Full sample	pre-2013 PTAs	Full sample
Current tariff	-2.086**	-1.601**	-2.986**	-1.549
	(1.002)	(0.775)	(1.396)	(0.966)
Lagged tariff, 1-year	-1.446*	-1.435**	-1.467	-1.104
	(0.862)	(0.623)	(1.088)	(0.729)
Lagged tariff, 2-year	0.623	0.146	0.554	-0.032
	(0.864)	(0.642)	(0.976)	(0.701)
Lagged tariff, 3-year	-0.746	-0.234	-0.705	-0.092
	(0.720)	(0.561)	(0.881)	(0.643)
MFN risk × Uncertainty index	1.490	0.162	-2.627***	-2.220***
	(1.191)	(0.774)	(0.506)	(0.392)
CA × MFN risk × Uncertainty index	1.136***	0.741***	1.055***	0.589**
	(0.305)	(0.254)	(0.325)	(0.268)
CA+MFN risk	2.625**	0.903	-1.573***	-1.632***
	(1.202)	(0.792)	(0.558)	(0.438)
Partner-product-month FE	Yes	Yes	Yes	Yes
Partner-time FE	Yes	Yes	Yes	Yes
Product-time FE	Yes	Yes	Yes	Yes
Observations	451,130	559,300	445,367	549,992
R2-within	0.0003	0.0001	0.0008	0.0006
AIC	1068267	1330268	1056503	1310922
BIC	1068377	1330380	1056613	1311034

Robust s.e. clustered at partner-CN8 level. * p<0.10, ** p<0.05, *** p<0.01. Columns 1-2 report the estimates based on the Handley Limao model. Columns 3-4 are based on the PRF model. In columns 1-2 the tariff is the log of one plus the preferential tariff, while in columns 3-4 it is the log weighted-average applied tariff $s^{PRF} \ln \tau^{PRF} + s^{MFN} \ln \tau^{MFN}$. The dependent variable is the log of UK imports from PTA partners excluding processing trade. For the HL model the MFN risk is measured as the tariff margin $\omega = 1 - (\tau^{PRF}/\tau^{MFN})^{\sigma}$ with $\sigma = 4$, while for the PRF model ω is interacted with the PRF import share. The Uncertainty index is the log of the Brexit Uncertainty Index (BUI). To deal with zeros in the BUI, I take the hyperbolic sine transformation $\ln[x + (1 + x^2)^{0.5}]$. The models include the interaction of the MFN risk, the current and up to two lags of the log of the BUI. The table reports the sum of the coefficients on the current and all lagged values interactions of BUI and the MFN risk. For Contiunity Agreements, the MFN risk and BUI are interacted with a dummy for CA signature. The row 'CA+MFN risk' reports the sum of the cumulative MFN and CA effects.

The results are similar to the baseline ones. The HL model does not detect significant uncertainty effects, but this time it picks up a positive effects of the Continuity Agreements. On the other hand, the PRF model finds both evidence of uncertainty and Continuity Agreements effects. As for the baseline model, the Continuity Agreements effects are smaller than the uncertainty ones, suggesting that the CA removed only 26-40% of the uncertainty introduced with the 2016 referendum.

5.3.3 Other robustness tests

The other robustness tests performed are:

Event study: To check if there are visible pre-treatment trends that can affect the main analysis, I run an event-study regression. The results are reported in Figure 8, and do not show particular signs of pre-trends.

Exporter-product shocks: I control for shocks at the exporter-product level by using as dependent variable the difference between the log of UK imports and the log of EU27 imports. If there were shocks at the exporter-product level that drive the results but are not correlated with uncertainty, they should affect UK and EU imports in the same way. The results, which are reported in Table 10, remain similar to the baseline results.

No-deal tariffs: In Table 11 I include the no-deal tariffs as specified in equation (24). The coefficients on the no-deal tariffs, both for uncertainty and Continuity Agreements, are never statistically significant, while the coefficients on the MFN risk remains similar to the baseline ones. This suggests that the no-deal tariffs were not perceived credible by exporters, which is in line with their temporary nature.

Excluding synthetic products: Product concordance over time implies aggregating products codes that merge and split over time. In Table 12 I exclude the products that merge and split, and find similar results to the baseline.

Including processing trade: In Table 13 I include processing trade, which is not subject to tariffs. Processing trade accounts only for a small value of total trade, and the empirical results are virtually unchanged compared to the baseline.

Presentation to Parliament for CA date: I re-estimate the model using the date of presentation to the UK Parliament of the Continuity Agreements rather than the signature date to construct the CA dummies. In this case, the HL model finds some positive effect of the CA (but still no uncertainty effects) while the PRF model finds no significant effect of the CAs.

Different levels of product-time FE: In Tables 15 and 16 I estimate the model with different levels of product-time fixed effects, both for the HL model (Table 15) and the PRF model (Table 16). This is done by estimating a restricted version of the baseline model where uncertainty effects are estimated for each year between 2016-19 rather than each year-month, and the effect of Continuity Agreements is estimated with a single dummy for the CA interacted with the uncertainty measure. Using the HL model I find negative and significant uncertainty effects only without any product-time FE. When I include HS2-time FE, only the uncertainty effect in 2019 remains negative and significant, and with product-time FE at more disaggregated levels, all the uncertainty effects vanish. On the other hand, estimates of the CA effects (without dealing with staggered adoption) remain stable and significant. For the PRF model (Table 16) the uncertainty effects are negative and significant across all specifications and tend to get bigger with finer levels of product-time FE. The CA effects remain stable across specifications. As discussed in section 5.1, the variation of preferential tariffs across countries is much more limited than the variation across products. On the other hand, the share of preferential imports has similar variation both across products and partners. Hence, the use of PRF share data allows me to identify uncertainty effects even with a strict fixed effect structure at the product-time level. These fixed effects can be important to absorb shocks affecting products over time common to all exporters.

Comparison with GHL: Graziano, Handley and Limão (2021) provide the only other estimate of Brexit uncertainty effects for PTA partners of the UK. For the sake of comparison, I estimate the specification with the Brexit Uncertainty Index of equation (23) – the most similar specification to GHL – on the same sample of PTA countries as in GHL: Iceland, Norway, Switzerland, Turkey, Mexico, Israel, Chile and South Korea. I report results based on both the HL and PRF models in Tables 17 and 18, respectively. For the sake of comparison, I include product-time fixed effects at different levels of product aggregation. Using the HL model, hence ignoring the share of PRF imports, I find a negative and significant effect of uncertainty only without product-time FE (see column 1 of Table 17). In this case I find a similar coefficient to GHL, who get -1.46 without product-time FE. On the other hand, using the PRF model the uncertainty effects are negative and significant with and without product-time FE, and increase in magnitude with product-time FE at more disaggregated product levels.

5.4 Interpretation and partial equilibrium quantification

This section presents an interpretation of results in light of the underlying theoretical model and a partial equilibrium quantification exercise. I show that using the regression coefficients, together with assumptions about some of the model's parameters, I can track the evolution of the probability of policy change γ_t over time. Moreover, I propose a simple partial equilibrium quantification exercise to provide ballpark numbers for the trade effects of uncertainty. This is done by taking into account the dynamic nature of the model and the presence of legacy firms.

According to the log-linearised theoretical model in equation (15), the time-specific uncertainty coefficients can be interpreted as:

$$\tilde{b}_T^{\gamma} = -\frac{\alpha - \sigma + 1}{\sigma - 1} \psi \frac{\beta}{1 - \beta} (1 - \lambda) \sum_{l=0}^{\infty} (1 - \psi)^l \gamma_{T-l}$$

where α is the shape parameter of the firm distribution, σ is the elasticity of substitution, β is a discount factor, ψ is the probability of firm's death, $(1 - \lambda)$ is the probability of a bad draw for future tariffs and γ_T is the probability of policy change. The ˜ means that we refer to the estimated coefficient. This expression says that the uncertainty coefficient measures both current and lagged levels of γ. This implies that for the first uncertain period (call it $t = 1$) the coefficient is:

$$\tilde{b}_1^{\gamma} = -\frac{\alpha - \sigma + 1}{\sigma - 1} \psi \frac{\beta}{1 - \beta} (1 - \lambda) \gamma_1$$

It can be shown that for each uncertainty period $T > 1$ we can write the ratio of the uncertainty coefficient in period T and the one in period 1 as:

$$\frac{\tilde{b}_T^{\gamma}}{\tilde{b}_1^{\gamma}} = \frac{\gamma_T}{\gamma_1} + \frac{\tilde{b}_{T-1}^{\gamma}}{\tilde{b}_1^{\gamma}} (1 - \psi)$$

Hence, using the regression coefficients and making an assumption about the exit rate parameter ψ, I can derive an estimate of the probability of policy change over time relative to the first uncertain period:

$$\frac{\gamma_T}{\gamma_1} = \frac{\tilde{b}_T^{\gamma}}{\tilde{b}_1^{\gamma}} - \frac{\tilde{b}_{T-1}^{\gamma}}{\tilde{b}_1^{\gamma}} (1 - \psi) \tag{26}$$

Doing so will allow us to see whether the pattern in the uncertainty coefficients seen in Figure 4 is mainly driven by changes in the level of uncertainty over time or whether it is driven by the presence of legacy firms in the data.

To provide a partial equilibrium quantification of the effects of uncertainty on UK imports value I have to account for the presence of legacy firms. I do so using the following approach. Trade X_t in each period t as observed in the product-level trade datasets is the sum of trade carried out by firms entering in period t and of firms that entered before and survived in period t. This can be written as $X_t = X_t^{new} + X_t^{sur}$ where X_t^{new} is exports of new firms and X_t^{sur} is exports of surviving firms that entered before period t. Now consider that we start from a steady state equilibrium with no uncertainty X_{ss}, and we want to compare the steady state to a counterfactual with uncertainty X_U. We can write:

$$\hat{X} = \frac{X_U}{X_{ss}} = \frac{X_U^{new} + X_U^{sur}}{X_{ss}} = \theta_{ss}\hat{X}^{new} + (1-\theta_{ss})\hat{X}^{sur}$$

where θ_{ss} is the exports share of new firms at the steady state and $\hat{x} = x'/x$ denotes the proportional change. At the steady state aggregate conditions are in equilibrium and the trail of past experience no longer matters. It can be shown that evaluating the share of survival firms at the steady state (hence fixing aggregate conditions at steady state equilibrium values $B_{jt} = B_j$, $m_{it} = m_i$ and $\tau_t = \tau$) is given by the survival rate $(1-\psi)$. Second, because uncertainty only affects the exporting decision of new firms, we have $\hat{X}^{sur} = 1$. Hence the counterfactual change in trade can be written as $\hat{X} = \psi\hat{X}^{new} + (1-\psi)$. This is true for the first period in which uncertainty arises. If we consider the counterfactual T periods ahead from the steady state we have:

$$\hat{X}_T = \psi \sum_{l=0}^{T} (1-\psi)^l \, \hat{X}_{T-l}^{new} + (1-\psi)^{T+1} \tag{27}$$

The proportional change in the value of exports of new firms due to uncertainty with tariffs evaluated at the base period value is given by:

$$\hat{X}_T^{new} = \frac{1 + \left(\left(\tau_{hj}^{MFN}/\tau_{hij}^{PRF}\right)^{\sigma} - 1\right)(F_{hij} \times U_T)^{-\alpha+\sigma-1}}{1 + \left(\left(\tau_{hj}^{MFN}/\tau_{hij}^{PRF}\right)^{\sigma} - 1\right)(F_{hij})^{-\alpha+\sigma-1}} \tag{28}$$

where $U_T = \left(\frac{1-\beta+\beta\gamma_T}{1-\beta+\beta\gamma_T\lambda}\right)^{\frac{1}{\sigma-1}}$ for the MFN threat analysed in the empirical section. I now discuss how this quantity can be measured from the data with some assumptions about the model's parameters. Tariff data are observed, and as for the empirical analysis I maintain the assumption $\sigma = 4$ for the elasticity of substitution across varieties. In the Appendix I show that in equilibrium we have:

$$F_{hij}^{-\alpha+\sigma-1} = \frac{X_{hij}^{PRF}}{X_{hij}^{PRF} + \left(\tau_{hj}^{MFN}/\tau_{hij}^{PRF}\right)^{\sigma} X_{hij}^{MFN}}$$

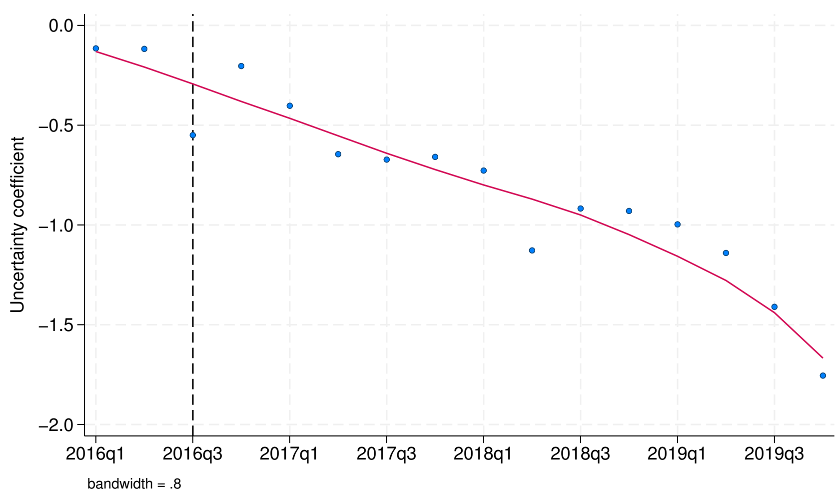
which is a modified share or preferential trade adjusted for the tariff margin. Equation (26) shows how to derive γ_T for each period relative to the first period of uncertainty γ_1. Hence, given a value of γ_1 we can derive the full path of γ. I follow Graziano, Handley and Limão (2021) in assuming that the discount factor β is composed only of the exogenous probability of death such that $\beta = 1 - \psi$. I also make an assumption about the shape parameter of the productivity distribution α, which we set equal to 5.5. Then I can derive:

$$\gamma_1 (1 - \lambda) = \frac{-\tilde{b}_1^{\gamma}}{1 - \psi} \frac{\sigma - 1}{\alpha - \sigma + 1} \tag{29}$$

where $\tilde{b}_1^{\gamma}$ is the uncertainty coefficient for the first uncertainty period. To evaluate the term U_T in (28) I have to separate the probability of policy change γ_1 from the probability of a bad draw from the tariff distribution $(1 - \lambda)$. Obviously, given the boundaries of $\gamma \in [0, 1]$, I am constrained in choosing a value for $(1 - \lambda)$ that must be larger than the RHS of (29). In the following application I consider $\lambda = 0.5$. I set the value of $\psi = 0.0375$ for quarterly data to match a death rate of 0.15 at the annual frequency in line with Steinberg (2019) and Costantini and Melitz (2008).

Before proceeding with the calculation, note that the monthly variation in the uncertainty and CA coefficients can contain quite some noise. I therefore take the quarterly average coefficient and smooth the series with a LOWESS local smoother to focus on the trend of uncertainty over time. The smoothing result for the quarterly uncertainty coefficients is presented in Figure 5.

Figure 5: Lowess smoother on quarterly uncertainty coefficients



The figure plots LOWESS smoothing results on quarterly average uncertainty coefficients.

I then compute the evolution of the probability of policy γ_T over time relative to 2016q3 as per equation (26) based on the smoothed series. This is shown in panel a of Figure 6, together with the Continuity Agreements effect.[16]

According to Figure 6, the major source of uncertainty has been the 2016 referendum. After that, the probability of policy change reduced sharply to around 40% of the 2016q3 level until mid-2018. From 2018q2 uncertainty rose again approaching the referendum levels at the end of 2019.

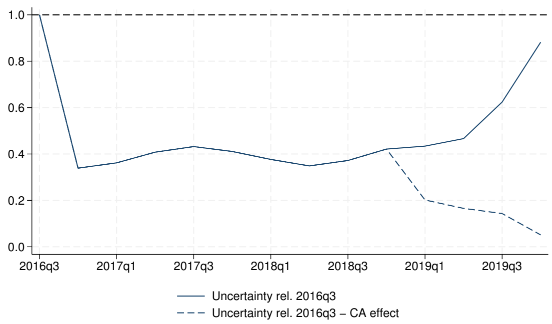
The estimated increase in uncertainty from mid-2018 is in line with the approaching of the Brexit deadline, originally set at the beginning of 2019. Moreover, the further increase in panel a of Figure 6 at the end of 2019 coincides with a series of events which most likely increased uncertainty regarding the UK-EU relation. Boris Johnson replaced Theresa May as prime minister in July 2019 when the Article 50 deadline for the UK exit was set on October 31. Johnson maintained a hard line on Brexit. He prorogued Parliament until October 14, although prorogation was then reversed, limiting its ability to discuss Brexit issues and re-wrote part of the deal reached with the EU by May's government. The Brexit deadline for a no-deal exit was moved to January 2020 only two days before the October 31 deadline. The country then held a general election on December 12. This series of events most likely increased uncertainty and the possibility of a policy reversal. At the same time, we see that the Continuity Agreements helped in keeping down the level of uncertainty at the moment when this was rising faster.

I then compute the counterfactual loss in UK imports for each quarter between 2016q3-2019q4 based on equation (27). This is done at the sample average values of tariffs and PRF share as reported in Table 2. The overall effect on UK imports is not large. By the end of 2019, accounting for the cumulation of uncertainty over time, the reduction in imports relative to the no-uncertainty counterfactual is -1.1%. Adding in Continuity Agreements this effect is reduced to -0.75% in 2019q4.

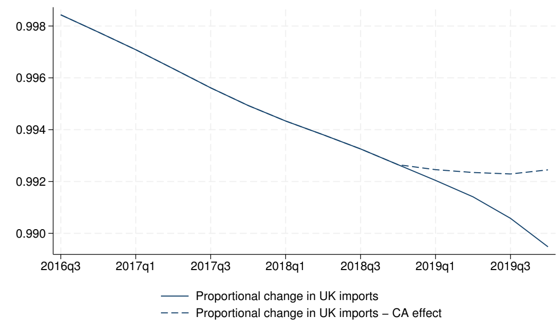
The drop in uncertainty after the referendum as plotted in panel a Figure 6 suggests that the trade effects between the referendum and mid-2018 as shown in panel b of Figure 6 are in large part driven by the presence of firms which entered in 2016q3 responding to the referendum news and survived thereafter. On the other hand, from mid-2018 the probability of policy change rose again hence the contribution of new firms to the aggregate trade effects increased in the last part of the sample period.

[16] I take the monthly average CA effects across cohorts and add them to the uncertainty coefficients. I then run the LOWESS smoothing on the series. For periods before 2019, I use the smoothed series on uncertainty only.

Figure 6: Counterfactual results



(a) Probability of policy change relative to 2016q3



(b) Proportional change in UK imports

The figures report the estimated evolution of the probability of policy change over time relative to 2016q3 (panel a) and the proportional change in UK imports implied by the counterfactual based on the model's equations.

6 Conclusion

In this paper I show how trade policy uncertainty can be modelled when countries are part of a trade agreement and utilising tariff preferences involves paying some fixed costs. Uncertainty about future tariff preferences deters firms from using these tariff preferences and pushes them into trading under the Most Favoured Nation regime. As more firms pay the MFN tariff, the total export value is reduced under uncertainty, and such reduction is proportional to the PRF/MFN tariff margin and to the preference utilisation rate. My theoretical results generalise the Handley and Limão model, which arises as the special case in which the preference utilisation rate is 100%.

When I apply the model empirically to UK's trade with PTA partners and Brexit, I find substantial support for the model in the data, and a formal statistical test rejects the restriction of full preference utilisation. My results show that when studying uncertainty about conditional tariff preferences, incorporating preference utilisation data can lead to substantially different empirical results. In general, when firms serve a market under different regimes, regime heterogeneity should be taken into account.

On the econometric side, I showed how to deal with staggered adoption using a flexible triple difference design. The result is an extension of Wooldridge (2021), who showed how to deal with staggered adoption in a difference-in-differences regression framework. Whether staggered adoption creates identification issues is ultimately an empirical question as it depends on the evolution of treatment effects over time.

The empirical results show that the uncertainty generated by the 2016 referendum negatively impacted on UK's trade with its PTA partners. The results are robust across a various range of specifications, and I find that the uncertainty effects evolved over time, decreasing immediately after the referendum only to increase again in 2019. This result is consistent both with the presence of legacy firms and with an increased probability of policy change. On the other hand, I find that the Continuity Agreements signed to replace the EU trade agreements only partly removed the uncertainty generated by the referendum. Overall, Continuity Agreements reduced uncertainty by around 1/3.

The paper shows that taking into account regime heterogeneity matters. Here I showed that it matters for the estimation of uncertainty effects. Most likely, this issue is important for the deterministic setting as well.

References

Agostino, Mariarosaria, Federica Demaria and Francesco Trivieri (2010). "Non-reciprocal trade preferences and the role of compliance costs in the agricultural sector: Exports to the EU". In: *Journal of Agricultural Economics* 61.3, pp. 652–679.

Albert, Christoph and Lars Nilsson (2016). *To Use, or Not to Use (Trade Preferences): That Is the Question*. Tech. rep. URL: https://www.etsg.org/ETSG2016/Papers/090.pdf.

Baldwin, Richard and Javier Lopez-Gonzalez (2015). "Supply-chain trade: A portrait of global patterns and several testable hypotheses". In: *The World Economy* 38.11, pp. 1682–1721.

Bloom, Nicholas et al. (2017). "Tracking the views of British businesses: evidence form the Decision Maker Panel". In: *Bank of England Quarterly Bulletin*, Q2.

Bureau, Jean-Christophe, Raja Chakir and Jacques Gallezot (2007). "The utilisation of trade preferences for developing countries in the agri-food sector". In: *Journal of Agricultural Economics* 58.2, pp. 175–198.

Callaway, Brantly and Pedro HC Sant'Anna (2021). "Difference-in-differences with multiple time periods". In: *Journal of Econometrics* 225.2, pp. 200–230.

Costantini, James A and Marc J Melitz (2008). "The dynamics of firm-level adjustment to trade liberalization". In: *E. Helpman, D. Marin, T. Verdier (Eds.), The organization of firms in a global economy*, pp. 107–141.

Crowley, Meredith, Oliver Exton and Lu Han (May 2020). "The Looming Threat of Tariff Hikes: Entry into Exporting under Trade Agreement Renegotiation". In: *AEA Papers and Proceedings* 110, pp. 547–551. DOI: 10.1257/pandp.20201020. URL: https://www.aeaweb.org/articles?id=10.1257/pandp.20201020.

Crowley, Meredith, Ning Meng and Huasheng Song (2018). "Tariff scares: Trade policy uncertainty and foreign market entry by Chinese firms". In: *Journal of International Economics* 114, pp. 96–115.

De Chaisemartin, Clément and Xavier d'Haultfoeuille (2020). "Two-Way Fixed Effects Estimators with Heterogeneous Treatment Effects". In: *American Economic Review* 110.9, pp. 2964–96.

Demidova, Svetlana and Kala Krishna (2008). "Firm heterogeneity and firm behavior with conditional policies". In: *Economics Letters* 98.2, pp. 122–128.
DIT (2019a). *Continuing the United Kingdom's Trade Relationship with the Republic of Korea*. Tech. rep. Department for International Trade.
– (2019b). *Continuing the United Kingdom's Trade Relationship with the Swiss Confederation*. Tech. rep. Department for International Trade.
– (2020). *Continuing the United Kingdom's Trade Relationship with Mexico*. Tech. rep. Department for International Trade.
Feng, Ling, Zhiyuan Li and Deborah L Swenson (2017). "Trade policy uncertainty and exports: Evidence from China's WTO accession". In: *Journal of International Economics* 106, pp. 20–36.
Gasiorek, Michael and Peter Holmes (2017). "Grandfathering: What Appears Bilateral Is Trilateral". In: *UKTPO Briefing Paper* 13.
Gasiorek, Michael, Julia Magntorn Garrett and L. Alan Winters (Mar. 2019 (Online)). *What should we make of the UKs "No Deal" tariffs?* UKTPO Blog. URL: https://blogs.sussex.ac.uk/uktpo/2019/03/14/what-should-we-make-of-the-uks-no-deal-tariffs/.
Goodman-Bacon, Andrew (2021). "Difference-in-differences with variation in treatment timing". In: *Journal of Econometrics*.
Graziano, Alejandro G, Kyle Handley and Nuno Limão (May 2020). "Brexit Uncertainty: Trade Externalities beyond Europe". In: *AEA Papers and Proceedings* 110, pp. 552–56. DOI: 10.1257/pandp.20201021. URL: https://www.aeaweb.org/articles?id=10.1257/pandp.20201021.
– (2021). "Brexit uncertainty and trade disintegration". In: *The Economic Journal* 131.635, pp. 1150–1185.
Hakobyan, Shushanik (2015). "Accounting for underutilization of trade preference programs: The US generalized system of preferences". In: *Canadian Journal of Economics* 48.2, pp. 408–436. DOI: https://doi.org/10.1111/caje.12131. eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1111/caje.12131. URL: https://onlinelibrary.wiley.com/doi/abs/10.1111/caje.12131.
Handley, Kyle (2014). "Exporting under trade policy uncertainty: Theory and evidence". In: *Journal of International Economics* 94.1, pp. 50–66.
Handley, Kyle and Nuno Limão (Nov. 2015). "Trade and Investment under Policy Uncertainty: Theory and Firm Evidence". In: *American Economic Journal: Economic Policy* 7.4, pp. 189–222. DOI: 10.1257/pol.20140068. URL: https://www.aeaweb.org/articles?id=10.1257/pol.20140068.
– (2017). "Policy Uncertainty, Trade, and Welfare: Theory and Evidence for China and the United States". In: *American Economic Review* 107.9, pp. 2731–2783.
– (2022). "Trade Policy Uncertainty". In: *Annual Review of Economics* 14.1, pp. 363–395. DOI: 10.1146/annurev-economics-021622-020416. eprint: https://doi.org/10.1146/annurev-economics-021622-020416. URL: https://doi.org/10.1146/annurev-economics-021622-020416.

Hayakawa, Kazunobu (2015). "Does firm size matter in exporting and using FTA schemes?" In: *The Journal of International Trade & Economic Development* 24.7, pp. 883–905.

Hayakawa, Kazunobu, Hansung Kim and Hyun-Hoon Lee (2014). "Determinants on utilization of the Korea–ASEAN free trade agreement: margin effect, scale effect, and ROO effect". In: *World Trade Review* 13.3, pp. 499–515.

Hayakawa, Kazunobu, Jinji Naoto et al. (2019). *Costs of Utilizing Regional Trade Agreements*. Tech. rep.

Helpman, Elhanan, Marc J Melitz and Stephen R Yeaple (2004). "Export Versus FDI with Heterogeneous Firms". In: *American Economic Review* 94.1, pp. 300–316.

Kasteng, Jonas, Ari Kokko and Patrik Tingvall (2022). "Who Uses the EU's Free Trade Agreements? A Transaction-Level Analysis of the EU–South Korea FTA". In: *World Trade Review* 21.1, pp. 93–108.

Keck, Alexander and Andreas Lendle (2012). "New evidence on preference utilization". In: *World Trade Organization Staff Working Paper No. ERSD-2012-12*.

Krishna, Kala et al. (2021). *Learning to Use Trade Agreements*. Tech. rep. National Bureau of Economic Research.

Limão, Nuno (2016). "Preferential trade agreements". In: *Handbook of commercial policy*. Vol. 1. Elsevier, pp. 279–367.

Magntorn Garrett, Julia (Oct. 2019 (Online)(a)). *The UKs "No Deal" Tariffs: An Update*. UKTPO Blog. URL: https://blogs.sussex.ac.uk/uktpo/2019/10/16/the-uks-no-deal-tariffs-an-update/.

– (Feb. 2019 (Online)(b)). *The UKs Continuity Trade Agreements: Missing in Inaction*. UKTPO Blog. URL: https://blogs.sussex.ac.uk/uktpo/2019/02/25/the-uks-continuity-trade-agreements-missing-in-inaction/.

Manchin, Miriam (2006). "Preference utilisation and tariff reduction in EU imports from ACP countries". In: *The World Economy* 29.9, pp. 1243–1266.

Melitz, Marc J (2003). "The impact of trade on intra-industry reallocations and aggregate industry productivity". In: *Econometrica* 71.6, pp. 1695–1725.

Nilsson, Lars and Caroline Dotter (2012). "Small flows, compliance costs and trade preferences: The case of EU imports from African LDCs". In: *Economics* 6.1.

Steinberg, Joseph B (2019). "Brexit and the macroeconomic impact of trade policy uncertainty". In: *Journal of International Economics* 117, pp. 175–195.

Takahashi, Katsuhide and Shujiro Urata (2010). "On the Use of FTAs by Japanese Firms: Further Evidence". In: *Business and Politics* 12.1, pp. 1–15. DOI: 10.2202/1469-3569.1310.

Ulloa, Alfie and Rodrigo Wagner (2012). *Why don't all exporters benefit from free trade agreements? Estimating Utilization Costs*. Tech. rep. IDB Working Paper Series.

Van Beveren, Ilke, Andrew B Bernard and Hylke Vandenbussche (2012). *Concording EU trade and production data over time*. Tech. rep. National Bureau of Economic Research.

Wooldridge, Jeffrey M (2021). "Two-way fixed effects, the two-way mundlak regression, and difference-in-differences estimators". In: *Available at SSRN 3906345*.

Appendix

A Theory

Model setting

Consumers aggregate consumption between a freely traded homogeneous good q_0 and a differentiated good Q with Cobb-Douglas preferences $U = q_0^{1-\mu} Q^{\mu}$. The aggregation of different varieties q_h is done with CES utility function $Q = \left[\int q_h^{\rho} dh\right]^{1/\rho}$ characterised by elasticity of substitution $\sigma = 1/(1-\rho) > 1$. Solving the utility maximisation problem gives the demand for a variety h from country i in country j as $q_{hijt} = p_{hijt}^{-\sigma} \mu Y_{jt} P_{jt}^{\sigma-1}$ where Y_{jt} is aggregate income of country j at time t, $P_{jt} = \left[\int p_{hjt}^{1-\sigma} dh\right]^{1/(1-\sigma)}$ is the CES price index and the price p_{hijt} is inclusive of trade costs $\delta_{ij} \geq 1$ and tariffs $\tau_{hijt} \geq 1$.

Firms are monopolistic competitors using labour as the only mean of production, which cost is pinned down to unity by the numeraire. They are also differentiated by their productivity level φ, and they maximise the profit $q_{hijt}\left(p_{hijt} - \delta_{ij}\tau_{hijt}/\varphi\right)$ yielding the optimal price as a constant markup over variable costs $p_{hijt} = \frac{\sigma}{\sigma-1}\frac{\delta_{ij}\tau_{hijt}}{\varphi}$, which depends on the firm's productivity φ. Using the residual demand and the price received by the firm (i.e., excluding tariffs) we can determine the operating profit of a firm as:

$$\pi_{hijt} = q_{hijt} p_{hijt}/\tau_{hijt} = \left(\frac{\sigma}{\sigma-1}\frac{\delta_{ij}}{\varphi}\right)^{1-\sigma} \tau_{hijt}^{-\sigma} \mu Y_{jt} P_{jt}^{\sigma-1} \tag{30}$$

Note that in the profit function (30) the tariff enters with an exponent of $-\sigma$, differently from the one on the iceberg transport cost δ_{ij} which is $1-\sigma$. This is because while transport costs can be passed to consumers, tariff revenues are collected by the customs authorities. Hence, the firm charging a price $p_{ij} = p_i\tau_{ij}$ to consumers will only receive a value p_i for each unit sold.

To start exporting from i to j a firm incurs an initial sunk cost. If countries i and j do not have an PTA the only option available to an exporter is the MFN regime. In this case the firm would pay sunk costs f_{hij} and face the MFN tariff τ_{hjt}^{MFN} . If on the other hand countries i and j have an PTA in place the firm can choose to export under the MFN or the preferential (PRF) regime. If she chooses to use preferences there is an additional sunk cost f_{hij}^{PRF}. These additional costs cover the research costs to understand which documents are necessary to use preferences, comply with bureaucracy etc. Hence sunk costs under the PRF regime are $f_{hij} + f_{hij}^{PRF}$. Under the PRF regime the firm has an advantage in variable costs as she faces the preferential tariff $\tau_{hijt}^{PRF} \leq \tau_{hjt}^{MFN}$. Upon entry, the firm decides whether to enter and under which strategy by maximising the present value of exporting. Given a discount factor $\beta < 1$, in the deterministic scenario the present values of the MFN and PRF regimes are:

$$V_{hijt}^{MFN} = \pi(\tau_{hjt}^{MFN}) + \sum_{t=1}^{\infty} \beta^t \pi(\tau_{hjt}^{MFN}) = \frac{\pi(\tau_{hjt}^{MFN})}{1-\beta}$$

$$V_{hijt}^{PRF} = \pi(\tau_{hijt}^{PRF}) + \sum_{t=1}^{\infty} \beta^t \pi(\tau_{hijt}^{PRF}) = \frac{\pi(\tau_{hijt}^{PRF})}{1-\beta}$$

The firm exports under the MFN regime if $V_{hijt}^{MFN} \geq f_{hij}$, while she chooses the PRF regime if $V_{hijt}^{PRF} - V_{hijt}^{MFN} \geq f_{hij} + f_{hij}^{PRF} - f_{hij} = f_{hij}^{PRF}$. The choice between the two regimes depends on the productivity of the firm. Because the PRF regime involves higher fixed costs but lower variable costs than the MFN regime, only the most productive firms will chose the PRF regime. This is because most productive firms will have higher sales volumes, so they can distribute the higher sunk costs across more units of product sold. This is the same result of (Helpman, Melitz and Yeaple 2004) in the export/FDI decision. We can determine the productivity cut-off above which the firm exports under the MFN regime φ_{hijt}^{MFN} by solving $V_{hijt}^{MFN} = f_{hij}$ for productivity:

$$\varphi_{hijt}^{MFN} = \left[\frac{f_{hij}\,(1-\beta)}{A_{ijt}\left(\tau_{hjt}^{MFN}\right)^{-\sigma}} \right]^{\frac{1}{\sigma-1}}$$

where $A_{ijt} = \left(\frac{\sigma}{\sigma-1}\delta_{ij}\right)^{1-\sigma} \mu Y_{jt} P_{jt}^{\sigma-1}$summarises market conditions. The cut-off for the PRF regime φ_{hijt}^{PRF} can be found solving $V_{hijt}^{PRF} - V_{hijt}^{MFN} = f_{hij}^{PRF}$ for φ:

$$\varphi = \left[\frac{f_{hij}^{PRF}\,(1-\beta)}{A_{ijt}\left[\left(\tau_{hjt}^{PRF}\right)^{-\sigma} - \left(\tau_{hjt}^{MFN}\right)^{-\sigma}\right]} \right]^{\frac{1}{\sigma-1}}$$

Then collect $\left(\tau_{hjt}^{MFN}\right)^{-\sigma}$ at the denominator and divide and multiply the numerator by f_{hij} to have:

$$\varphi_{hijt}^{PRF} = \left[\frac{f_{hij}\,(1-\beta)}{A_{ijt}\left(\tau_{hjt}^{MFN}\right)^{-\sigma}} \right]^{\frac{1}{\sigma-1}} \left[\frac{f_{hij}^{PRF}/f_{hij}}{\left(\tau_{hjt}^{MFN}/\tau_{hijt}^{PRF}\right)^{\sigma} - 1} \right]^{\frac{1}{\sigma-1}}$$

where the second term measures the ratio of the proportional increase in fixed costs f_{hij}^{PRF}/f_{hij} over the proportional saving in variable costs $\left(\tau_{hjt}^{MFN}/\tau_{hijt}^{PRF}\right)^{\sigma} - 1$. It is clear that we have $\varphi_{hijt}^{PRF} > \varphi_{hijt}^{MFN}$, and therefore observe MFN trade, if and only if

$$f_{hij}^{PRF}/f_{hij} > \left(\tau_{hjt}^{MFN}/\tau_{hijt}^{PRF}\right)^{\sigma} - 1$$

This condition is very general and it states that firms will choose the MFN regime only if the proportional increase in fixed costs associated with the PRF regime is larger than the proportional increase in prices given by the MFN regime.

Derivation of exports value under uncertainty for new firms

To find the value of exports of firms arriving in period t I integrate firm sales over productivity, which has a Pareto distribution $G(\varphi) = 1 - \varphi^{-\alpha}$. The value of PRF exports is then the value of exports of all firms above the PRF cut-off:

$$X_{hijt}^{PRF} = A_{ijt}\left(\tau_{hijt}^{PRF}\right)^{-\sigma} m_{it} \int_{\varphi^{UPRF}}^{\infty} \varphi^{\sigma-1} dG(\varphi) = A_{ijt}\left(\tau_{hijt}^{PRF}\right)^{-\sigma} m_{it} \frac{\alpha}{\alpha-\sigma+1}\left(\varphi_{hijt}^{UPRF}\right)^{-\alpha+\sigma-1}$$

$$X_{hijt}^{PRF} = A_{ijt}\left(\tau_{hijt}^{PRF}\right)^{-\sigma} m_{it} \frac{\alpha}{\alpha-\sigma+1}\left(\varphi_{hijt}^{MFN} \times F_{hijt} \times U_t\right)^{-\alpha+\sigma-1}$$

$$X_{hijt}^{PRF} = A_{ijt}^{\frac{\alpha}{\sigma-1}}\left(\tau_{hjt}^{MFN}/\tau_{hijt}^{PRF}\right)^{\sigma}\left(\tau_{hjt}^{MFN}\right)^{-\frac{\sigma\alpha}{\sigma-1}} m_{it} \frac{\alpha}{\alpha-\sigma+1}\left[f_{hij}(1-\beta)\right]^{\frac{-\alpha+\sigma-1}{\sigma-1}}\left(F_{hijt} \times U_t\right)^{-\alpha+\sigma-1}$$

For the value of exports under the MFN regime we have to integrate firms' revenues between the MFN and PRF cut-offs:

$$X_{hijt}^{MFN} = A_{jt}\left(\tau_{hjt}^{MFN}\right)^{-\sigma} m_{it} \int_{\varphi^{MFN}}^{\varphi^{UPRF}} \varphi^{\sigma-1} dG(\varphi)$$

$$X_{hijt}^{MFN} = A_{jt}\left(\tau_{hjt}^{MFN}\right)^{-\sigma} m_{it} \frac{\alpha}{\alpha-\sigma+1}\left[\left(\varphi_{hijt}^{MFN}\right)^{-\alpha+\sigma-1} - \left(\varphi_{hijt}^{UPRF}\right)^{-\alpha+\sigma-1}\right]$$

$$X_{hijt}^{MFN} = A_{jt}\left(\tau_{hjt}^{MFN}\right)^{-\sigma} m_{it} \frac{\alpha}{\alpha-\sigma+1}\left(\varphi_{hijt}^{MFN}\right)^{-\alpha+\sigma-1}\left[1 - \left(F_{hijt} \times U_t\right)^{-\alpha+\sigma-1}\right]$$

$$X_{hijt}^{MFN} = A_{ijt}^{\frac{\alpha}{\sigma-1}}\left(\tau_{hjt}^{MFN}\right)^{-\frac{\sigma\alpha}{\sigma-1}} m_{it} \frac{\alpha}{\alpha-\sigma+1}\left[f_{hij}(1-\beta)\right]^{\frac{-\alpha+\sigma-1}{\sigma-1}}\left[1 - \left(F_{hijt} \times U_t\right)^{-\alpha+\sigma-1}\right]$$

We can then find total exports by adding X_{hijt}^{MFN} and X_{hijt}^{PRF}:

$$X_{hijt} = X_{hijt}^{MFN} + X_{hijt}^{PRF} = A_{ijt}^{\frac{\alpha}{\sigma-1}}\left(\tau_{hjt}^{MFN}\right)^{-\frac{\sigma\alpha}{\sigma-1}} m_{it} \frac{\alpha}{\alpha-\sigma+1}\left[f_{hij}(1-\beta)\right]^{\frac{-\alpha+\sigma-1}{\sigma-1}} \times \left[\left(\frac{\tau_{hjt}^{MFN}}{\tau_{hijt}^{PRF}}\right)^{\sigma}\left(F_{hijt} \times U_t\right)^{-\alpha+\sigma-1} + 1 - \left(F_{hijt} \times U_t\right)^{-\alpha+\sigma-1}\right]$$

$$X_{hijt} = A_{ijt}^{\frac{\alpha}{\sigma-1}}\left(\tau_{hjt}^{MFN}\right)^{-\frac{\sigma\alpha}{\sigma-1}} m_{it} \frac{\alpha}{\alpha-\sigma+1}\left[f_{hij}(1-\beta)\right]^{\frac{-\alpha+\sigma-1}{\sigma-1}} \times \left[1 + \left(\left(\frac{\tau_{hjt}^{MFN}}{\tau_{hijt}^{PRF}}\right)^{\sigma} - 1\right)\left(F_{hijt} \times U_t\right)^{-\alpha+\sigma-1}\right]$$

Recalling that $A_{ijt} = \left(\frac{\sigma}{\sigma-1}\delta_{ij}\right)^{1-\sigma} \mu Y_{jt} P_{jt}^{\sigma-1}$ we can collect the following terms: $B_{jt} = Y_{jt} P_{jt}^{\sigma-1}$ summarises constant terms and aggregate demand conditions, m_{it} summarises supply conditions and

$$C_{hij} = \left(\frac{\alpha}{\alpha-\sigma+1}\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma}\mu\right)^{\frac{\alpha}{\sigma-1}} \delta_{ij}^{-\alpha}\left[f_{hij}\left(1-\beta\right)\right]^{\frac{-\alpha+\sigma-1}{\sigma-1}}$$

summarises time-invariant barriers to trade. Then total exports is equation (11) in the text.

The value of exports with legacy firms

In product-level trade data at each point in time the observed value of exports is the sum of exports of new firms and exports of firms that entered in the past and are still trading today. Hence, we observe the following quantities for PRF and MFN trade in the data:

$$X_{hijt}^{PRF} = A_{ijt}\left(\tau_{hijt}^{PRF}\right)^{-\sigma}\frac{\alpha}{\alpha-\sigma+1}\sum_{l=0}^{\infty}\left(1-\psi\right)^{l} m_{it-l}\left(\varphi_{hijt-l}^{UPRF}\right)^{-\alpha+\sigma-1}$$

$$X_{hijt}^{MFN} = A_{jt}\left(\tau_{hjt}^{MFN}\right)^{-\sigma}\frac{\alpha}{\alpha-\sigma+1}\sum_{l=0}^{\infty}\left(1-\psi\right)^{l} m_{it-l}\left(\varphi_{hijt-l}^{MFN}\right)^{-\alpha+\sigma-1}\left[1-\left(F_{hijt-l}\times U_{t-l}\right)^{-\alpha+\sigma-1}\right]$$

where l stands for lags and ψ is the exogenous probability of death of a firm. Total trade is the sum of PRF and MFN trade:

$$X_{hijt} = A_{ijt}\frac{\alpha}{\alpha-\sigma+1}\left(\tau_{hjt}^{MFN}\right)^{-\sigma}\times$$
$$\left[\left(\frac{\tau_{hjt}^{MFN}}{\tau_{hijt}^{PRF}}\right)^{\sigma}\sum_{l=0}^{\infty}\left(1-\psi\right)^{l} m_{it-l}\left(\varphi_{hijt-l}^{UPRF}\right)^{-\alpha+\sigma-1}+\sum_{l=0}^{\infty}\left(1-\psi\right)^{l} m_{it-l}\left(\varphi_{hijt-l}^{MFN}\right)^{-\alpha+\sigma-1}\left[1-\left(F_{hijt-l}\times U_{t-l}\right)^{-\alpha+\sigma-1}\right]\right]$$

considering that $\varphi_{hijt-l}^{UPRF} = \varphi_{hijt-l}^{MFN}\times F_{hijt-l}\times U_{t-l}$ and regrouping terms within the sum:

$$X_{hijt} = A_{ijt}\frac{\alpha}{\alpha-\sigma+1}\left(\tau_{hjt}^{MFN}\right)^{-\sigma}\times$$
$$\left\{\sum_{l=0}^{\infty}\left(1-\psi\right)^{l} m_{it-l}\left(\varphi_{hijt-l}^{MFN}\right)^{-\alpha+\sigma-1}\left[1+\left(\left(\frac{\tau_{hjt}^{MFN}}{\tau_{hijt}^{PRF}}\right)^{\sigma}-1\right)\left(F_{hijt-l}\times U_{t-l}\right)^{-\alpha+\sigma-1}\right]\right\}$$

recalling that $\varphi_{hijt-l}^{MFN}=\left[\frac{f_{hij}(1-\beta)}{A_{ijt}\left(\tau_{hjt}^{MFN}\right)^{-\sigma}}\right]^{\frac{1}{\sigma-1}}$ and using the definitions of B_{jt} and C_{hij} given above we have:

$$X_{hijt}=B_{jt}C_{hij}\left(\tau_{hjt}^{MFN}\right)^{-\sigma}\times \left\{\sum_{l=0}^{\infty}\left(1-\psi\right)^{l}m_{it-l}\left(B_{jt-l}\left(\tau_{hjt-l}^{MFN}\right)^{-\sigma}\right)^{\frac{\alpha-\sigma+1}{\sigma-1}}\left[1+\left(\left(\frac{\tau_{hjt}^{MFN}}{\tau_{hijt}^{PRF}}\right)^{\sigma}-1\right)\left(F_{hijt-l}\times U_{t-l}\right)^{-\alpha+\sigma-1}\right]\right\}$$

Log-linear approximation

In this section I derive the log-linear approximation of the value of exports that leads to the empirical equation. The value of exports in logarithm is:

$$\ln X_{hijt}=\ln B_{jt}+\ln C_{hij}-\sigma\ln\tau_{hjt}^{MFN}+ \ln\left\{\sum_{l=0}^{\infty}\left(1-\psi\right)^{l}m_{it-l}\left(B_{jt-l}\left(\tau_{hjt-l}^{MFN}\right)^{-\sigma}\right)^{\frac{\alpha-\sigma+1}{\sigma-1}}\left[1+\left(\left(\frac{\tau_{hjt}^{MFN}}{\tau_{hijt}^{PRF}}\right)^{\sigma}-1\right)\left(F_{hijt-l}\times U_{t-l}\right)^{-\alpha+\sigma-1}\right]\right\} \quad (31)$$

I then take the log-linear approximation of the equation around $B_{jt-l}=B_{j0}$, $\tau_{hjt-l}^{MFN}=\tau_{hj0}^{MFN}$, $\tau_{hijt-l}^{PRF}=\tau_{hij0}^{PRF}$, $m_{it-l}=m_{i0}$ and $\gamma_{t-l}=0$ for every l between 0 and ∞. The following paragraphs report the partial derivatives of equation (31) with respect to each time varying term, and then evaluate them at the equilibrium point 0. The last paragraphs combines them together to show the log-linear approximation of (31).

Approximation with respect to B_{jt-l} Take the derivative of (31) with respect to $\ln B_{jt-l}$:

$$\frac{\partial\ln X_{hijt}}{\partial\ln B_{jt-l}}=\frac{\alpha-\sigma+1}{\sigma-1}\frac{\left(1-\psi\right)^{l}m_{it-l}\left(B_{jt-l}\left(\tau_{hjt-l}^{MFN}\right)^{-\sigma}\right)^{\frac{\alpha-\sigma+1}{\sigma-1}}\left[1+\left(\left(\frac{\tau_{hjt}^{MFN}}{\tau_{hijt}^{PRF}}\right)^{\sigma}-1\right)\left(F_{hijt-l}\times U_{t-l}\right)^{-\alpha+\sigma-1}\right]}{\sum_{l=0}^{\infty}\left(1-\psi\right)^{l}m_{it-l}\left(B_{jt-l}\left(\tau_{hjt-l}^{MFN}\right)^{-\sigma}\right)^{\frac{\alpha-\sigma+1}{\sigma-1}}\left[1+\left(\left(\frac{\tau_{hjt}^{MFN}}{\tau_{hijt}^{PRF}}\right)^{\sigma}-1\right)\left(F_{hijt-l}\times U_{t-l}\right)^{-\alpha+\sigma-1}\right]}$$

Then evaluate at the steady state $t=0$:

$$\frac{\partial\ln X_{hijt}}{\partial\ln B_{jt-l}}=\frac{\alpha-\sigma+1}{\sigma-1}\frac{\left(1-\psi\right)^{l}}{\sum_{l=0}^{\infty}\left(1-\psi\right)^{l}}=\frac{\alpha-\sigma+1}{\sigma-1}\left(1-\psi\right)^{l}\psi$$

and for the current value we also have a +1.

Approximation with respect to m_{it-l} Take the derivative of (31) with respect to $\ln m_{it-l}$:

$$\frac{\partial \ln X_{hijt}}{\partial \ln m_{it-l}} = \frac{(1-\psi)^l\, m_{it-l}\left(B_{jt-l}\left(\tau_{hjt-l}^{MFN}\right)^{-\sigma}\right)^{\frac{\alpha-\sigma+1}{\sigma-1}}\left[1+\left(\left(\frac{\tau_{hjt}^{MFN}}{\tau_{hijt}^{PRF}}\right)^{\sigma}-1\right)\left(F_{hijt-l}\times U_{t-l}\right)^{-\alpha+\sigma-1}\right]}{\sum_{l=0}^{\infty}(1-\psi)^l\, m_{it-l}\left(B_{jt-l}\left(\tau_{hjt-l}^{MFN}\right)^{-\sigma}\right)^{\frac{\alpha-\sigma+1}{\sigma-1}}\left[1+\left(\left(\frac{\tau_{hjt}^{MFN}}{\tau_{hijt}^{PRF}}\right)^{\sigma}-1\right)\left(F_{hijt-l}\times U_{t-l}\right)^{-\alpha+\sigma-1}\right]}$$

Then evaluate at the steady state $t=0$:

$$\frac{\partial \ln X_{hijt}}{\partial \ln m_{it-l}} = (1-\psi)^l\,\psi$$

Approximation with respect to current MFN tariff To take the derivative of (31) with respect to $\ln \tau_{hjt}^{MFN}$, note that:

$$\left(\left(\frac{\tau_{hjt}^{MFN}}{\tau_{hijt}^{PRF}}\right)^{\sigma}-1\right)\left(F_{hijt}\times U_t\right)^{-\alpha+\sigma-1} = \left(\left(\frac{\tau_{hjt}^{MFN}}{\tau_{hijt}^{PRF}}\right)^{\sigma}-1\right)^{\frac{\alpha}{\sigma-1}}\left(\frac{f_{hij}^{PRF}}{f_{hij}}\right)^{\frac{-\alpha+\sigma-1}{\sigma-1}}\left(U_t\right)^{-\alpha+\sigma-1}$$

Then we have:

$$\frac{\partial \ln X_{hijt}}{\partial \ln \tau_{hjt}^{MFN}} = -\sigma + \frac{m_{it}B_{jt}^{\frac{\alpha-\sigma+1}{\sigma-1}}\left\{-\sigma\frac{\alpha-\sigma+1}{\sigma-1}\left(\tau_{hjt}^{MFN}\right)^{-\sigma\frac{\alpha-\sigma+1}{\sigma-1}}\left[1+\left(\left(\frac{\tau_{hjt}^{MFN}}{\tau_{hijt}^{PRF}}\right)^{\sigma}-1\right)^{\frac{\alpha}{\sigma-1}}\left(\frac{f_{hij}^{PRF}}{f_{hij}}\right)^{\frac{-\alpha+\sigma-1}{\sigma-1}}\left(U_t\right)^{-\alpha+\sigma-1}\right]\right\}}{\sum_{l=0}^{\infty}(1-\psi)^l\, m_{it-l}\left(B_{jt-l}\left(\tau_{hjt-l}^{MFN}\right)^{-\sigma}\right)^{\frac{\alpha-\sigma+1}{\sigma-1}}\left[1+\left(\left(\frac{\tau_{hjt}^{MFN}}{\tau_{hijt}^{PRF}}\right)^{\sigma}-1\right)\left(F_{hijt-l}\times U_{t-l}\right)^{-\alpha+\sigma-1}\right]} +$$

$$\frac{m_{it}B_{jt}^{\frac{\alpha-\sigma+1}{\sigma-1}}\left(\tau_{hjt}^{MFN}\right)^{-\sigma\frac{\alpha-\sigma+1}{\sigma-1}}\frac{\alpha\sigma}{\sigma-1}\left(\left(\frac{\tau_{hjt}^{MFN}}{\tau_{hijt}^{PRF}}\right)^{\sigma}-1\right)^{\frac{\alpha}{\sigma-1}-1}\left(\frac{f_{hij}^{PRF}}{f_{hij}}\right)^{\frac{-\alpha+\sigma-1}{\sigma-1}}\left(U_t\right)^{-\alpha+\sigma-1}\left(\frac{\tau_{hjt}^{MFN}}{\tau_{hijt}^{PRF}}\right)^{\sigma}}{\sum_{l=0}^{\infty}(1-\psi)^l\, m_{it-l}\left(B_{jt-l}\left(\tau_{hjt-l}^{MFN}\right)^{-\sigma}\right)^{\frac{\alpha-\sigma+1}{\sigma-1}}\left[1+\left(\left(\frac{\tau_{hjt}^{MFN}}{\tau_{hijt}^{PRF}}\right)^{\sigma}-1\right)\left(F_{hijt-l}\times U_{t-l}\right)^{-\alpha+\sigma-1}\right]}$$

Evaluate at the steady state $t=0$, simplify and rearrange to get:

$$\frac{\partial \ln X_{hijt}}{\partial \ln \tau_{hjt}^{MFN}} = -\sigma + \psi\left[-\frac{\sigma\alpha}{\sigma-1}+\sigma+\frac{\alpha\sigma}{\sigma-1}\underbrace{\frac{\left(\frac{\tau_{hjt}^{MFN}}{\tau_{hijt}^{PRF}}\right)^{\sigma}\left(F_{hij0}\right)^{-\alpha+\sigma-1}}{1+\left(\left(\frac{\tau_{hj0}^{MFN}}{\tau_{hij0}^{PRF}}\right)^{\sigma}-1\right)\left(F_{hij0}\right)^{-\alpha+\sigma-1}}}_{\text{Long run share of PRF trade}}\right]$$

$$\frac{\partial \ln X_{hijt}}{\partial \ln \tau_{hjt}^{MFN}} = -\sigma(1-\psi) - \frac{\alpha\sigma}{\sigma-1}\psi\left(1-s_{hij}^{PRF}\right)$$

where s_{hij}^{PRF} is the equilibrium share of PRF trade.

Approximation with respect to lagged MFN tariff Take the derivative $\frac{\partial \ln X_{hijt}}{\partial \ln \tau^{MFN}_{hjt-l}}$ and evaluate at the steady state $t=0$:

$$\frac{\partial \ln X_{hijt}}{\partial \ln \tau^{MFN}_{hjt-l}} = -\sigma \frac{\alpha-\sigma+1}{\sigma-1} \frac{(1-\psi)^l}{\sum_{l=0}^{\infty}(1-\psi)^l} \left[1 - \underbrace{\frac{\left(\frac{\tau^{MFN}_{hjt0}}{\tau^{PRF}_{hij0}}\right)^{\sigma} (F_{hij0})^{-\alpha+\sigma-1}}{1+\left(\left(\frac{\tau^{MFN}_{hj0}}{\tau^{PRF}_{hij0}}\right)^{\sigma}-1\right)(F_{hij0})^{-\alpha+\sigma-1}}}_{\text{Long run share of PRF trade}} \right]$$

$$\frac{\partial \ln X_{hijt}}{\partial \ln \tau^{MFN}_{hjt-l}} = -\sigma \frac{\alpha-\sigma+1}{\sigma-1} \psi (1-\psi)^l \left(1 - s^{PRF}_{hij}\right)$$

Approximation with respect to the current PRF tariff Take $\frac{\partial \ln X_{hijt}}{\partial \ln \tau^{PRF}_{hijt}}$ and evaluate at the steady state $t=0$:

$$\frac{\partial \ln X_{hijt}}{\partial \ln \tau^{PRF}_{hijt}} = -\frac{\sigma\alpha}{\sigma-1} \underbrace{\frac{\left(\frac{\tau^{MFN}_{hj0}}{\tau^{PRF}_{hij0}}\right)^{\sigma} (F_{hij0})^{-\alpha+\sigma-1}}{1+\left(\left(\frac{\tau^{MFN}_{hj0}}{\tau^{PRF}_{hij0}}\right)^{\sigma}-1\right)(F_{hij0})^{-\alpha+\sigma-1}}}_{\text{Long run share of PRF trade}} \psi = -\frac{\sigma\alpha}{\sigma-1} \psi s^{PRF}_{hij}$$

Approximation with respect to lagged PRF tariff Take $\frac{\partial \ln X_{hijt}}{\partial \ln \tau^{PRF}_{hijt-l}}$ and evaluate at the steady state $t=0$:

$$\frac{\partial \ln X_{hijt}}{\partial \ln \tau^{PRF}_{hijt-l}} = \frac{(1-\psi)^l \left[(F_{hij0})^{-\alpha+\sigma-1} \frac{\alpha-\sigma+1}{\sigma-1}(-\sigma)\left(\frac{\tau^{MFN}_{hj0}}{\tau^{PRF}_{hij0}}\right)^{\sigma}\right]}{\sum_{l=0}^{\infty}(1-\psi)^l \left[1+\left(\left(\frac{\tau^{MFN}_{hj0}}{\tau^{PRF}_{hij0}}\right)^{\sigma}-1\right)(F_{hij0})^{-\alpha+\sigma-1}\right]} = -\sigma \frac{\alpha-\sigma+1}{\sigma-1} (1-\psi)^l \psi s^{PRF}_{hij}$$

Approximation with respect to current uncertainty

$$\frac{\partial \ln X_{hijt}}{\partial \gamma_t} = -\frac{\alpha-\sigma+1}{\sigma-1}\times$$

$$\frac{m_{it}B_{jt}^{\frac{\alpha-\sigma+1}{\sigma-1}}\left(\tau_{hjt}^{MFN}\right)^{-\sigma\frac{\alpha-\sigma+1}{\sigma-1}}\left(\left(\frac{\tau_{hjt}^{MFN}}{\tau_{hijt}^{PRF}}\right)^{\sigma}-1\right)^{\frac{-\alpha+\sigma-1}{\sigma-1}}\left(F_{hijt}\times U_t\right)^{-\alpha+\sigma-1}U_t^{-1}}{\sum_{l=0}^{\infty}\left(1-\psi\right)^l m_{it-l}B_{jt-l}^{\frac{\alpha-\sigma+1}{\sigma-1}}\left(\tau_{hjt-l}^{MFN}\right)^{-\sigma\frac{\alpha-\sigma+1}{\sigma-1}}\left[1+\left(\left(\frac{\tau_{hjt}^{MFN}}{\tau_{hijt}^{PRF}}\right)^{\sigma}-1\right)\left(F_{hijt-l}\times U_{t-l}\right)^{-\alpha+\sigma-1}\right]}\times$$

$$\frac{\beta\left(1-\beta+\beta\gamma_t\omega_{hij}^{PRF}\right)-\beta\omega_{hij}\left(1-\beta+\beta\gamma_t\right)}{\left(1-\beta+\beta\gamma_t\omega_{hij}^{PRF}\right)^2}$$

Now evaluate at the steady state and $\gamma=0$:

$$\frac{\partial \ln X_{hijt}}{\partial \gamma_t} = -\frac{\alpha-\sigma+1}{\sigma-1}\left[\left(\frac{\tau_{hj0}^{MFN}}{\tau_{hij0}^{PRF}}\right)^{\sigma}-1\right]\frac{\left(F_{hij0}\right)^{-\alpha+\sigma-1}}{1+\left[\left(\frac{\tau_{hj0}^{MFN}}{\tau_{hij0}^{PRF}}\right)^{\sigma}-1\right]\left(F_{hij0}\right)^{-\alpha+\sigma-1}}\psi\frac{\beta}{1-\beta}\left(1-\omega_{hij}^{PRF}\right)$$

Divide and multiply by $\left(\frac{\tau_{hj0}^{MFN}}{\tau_{hij0}^{PRF}}\right)^{\sigma}$ to have

$$\frac{\partial \ln X_{hijt}}{\partial \gamma_t} = -\frac{\alpha-\sigma+1}{\sigma-1}\left[1-\left(\frac{\tau_{hj0}^{MFN}}{\tau_{hij0}^{PRF}}\right)^{-\sigma}\right]\underbrace{\frac{\left(\frac{\tau_{hj0}^{MFN}}{\tau_{hij0}^{PRF}}\right)^{\sigma}\left(F_{hij0}\right)^{-\alpha+\sigma-1}}{1+\left[\left(\frac{\tau_{hj0}^{MFN}}{\tau_{hij0}^{PRF}}\right)^{\sigma}-1\right]\left(F_{hij0}\right)^{-\alpha+\sigma-1}}}_{\text{Long run share of PRF trade}}\psi\frac{\beta}{1-\beta}\left(1-\omega_{hij}^{PRF}\right)=$$

$$-\frac{\alpha-\sigma+1}{\sigma-1}\left[1-\left(\frac{\tau_{hj0}^{MFN}}{\tau_{hij0}^{PRF}}\right)^{-\sigma}\right]s_{hij}^{PRF}\psi\frac{\beta}{1-\beta}\left(1-\omega_{hij}^{PRF}\right)$$

Under the MFN threat we have $E_t\left(\tau^{-\sigma}|\tau'>\tau_{hijt}^{PRF}\right)=\left(\tau^{MFN}\right)^{-\sigma}$ hence $\omega_{hij}^{PRF}=\lambda$. Then:

$$\frac{\partial \ln X_{hijt}}{\partial \gamma_t} = -\frac{\alpha-\sigma+1}{\sigma-1}\psi\frac{\beta}{1-\beta}\left(1-\lambda\right)s_{hij}^{PRF}\left[1-\left(\frac{\tau_{hij0}^{PRF}}{\tau_{hj0}^{MFN}}\right)^{\sigma}\right]$$

Approximation with respect to lagged uncertainty Similarly, take $\frac{\partial \ln X_{hijt}}{\partial \gamma_{t-l}}$ and evaluate at steady state to get:

$$\frac{\partial \ln X_{hijt}}{\partial \gamma_{t-l}} = -\frac{\alpha-\sigma+1}{\sigma-1}\psi\left(1-\psi\right)^l\frac{\beta}{1-\beta}\left(1-\lambda\right)s_{hij}^{PRF}\left[1-\left(\frac{\tau_{hij0}^{PRF}}{\tau_{hj0}^{MFN}}\right)^{\sigma}\right]$$

The estimating equation Combining all the derivatives evaluated at the long run equilibrium with $\gamma = 0$ we have the log-linear approximation of exports as:

$$\begin{aligned}\ln X_{hijt|t=0,\gamma=0} = {} & \ln C_{hij} + \frac{\alpha-\sigma+1}{\sigma-1}\psi\sum_{l=0}^{\infty}(1-\psi)^l \ln\left(\frac{B_{jt-l}}{B_{j0}}\right) + \psi\sum_{l=0}^{\infty}(1-\psi)^l \ln\left(\frac{m_{it-l}}{m_{i0}}\right) + \\ & -\sigma(1-\psi)\ln\left(\frac{\tau_{hjt}^{MFN}}{\tau_{hj0}^{MFN}}\right) - \frac{\alpha\sigma}{\sigma-1}\psi\left[s_{hij0}^{MFN}\ln\left(\frac{\tau_{hjt}^{MFN}}{\tau_{hj0}^{MFN}}\right) + s_{hij0}^{PRF}\ln\left(\frac{\tau_{hijt}^{PRF}}{\tau_{hij0}^{PRF}}\right)\right] + \\ & -\sigma\frac{\alpha-\sigma+1}{\sigma-1}\psi\sum_{l=1}^{\infty}(1-\psi)^l\left[s_{hij0}^{MFN}\ln\left(\frac{\tau_{hjt-l}^{MFN}}{\tau_{hj0}^{MFN}}\right) + s_{hij0}^{PRF}\ln\left(\frac{\tau_{hijt-l}^{PRF}}{\tau_{hij0}^{PRF}}\right)\right] + \\ & -\frac{\alpha-\sigma+1}{\sigma-1}\psi\frac{\beta}{1-\beta}(1-\lambda)s_{hij0}^{PRF}\left[1-\left(\frac{\tau_{hij0}^{PRF}}{\tau_{hj0}^{MFN}}\right)^{\sigma}\right]\sum_{l=0}^{\infty}(1-\psi)^l\gamma_{t-l}\end{aligned}$$

which is equation 14 in the text.

Equilibrium share of preferential trade

The share of PRF trade in any period is computed as the ratio of PRF exports over total exports:

$$s_{hijt}^{PRF} = \left(\frac{\tau_{hjt}^{MFN}}{\tau_{hijt}^{PRF}}\right)^{\sigma}\frac{\sum_{l=0}^{\infty}(1-\psi)^l m_{it-l}\left(B_{jt-l}\left(\tau_{hjt-l}^{MFN}\right)^{-\sigma}\right)^{\frac{\alpha-\sigma+1}{\sigma-1}}\left(F_{hijt-l}\times U_{t-l}\right)^{-\alpha+\sigma-1}}{\sum_{l=0}^{\infty}(1-\psi)^l m_{it-l}\left(B_{jt-l}\left(\tau_{hjt-l}^{MFN}\right)^{-\sigma}\right)^{\frac{\alpha-\sigma+1}{\sigma-1}}\left[1+\left(\left(\frac{\tau_{hjt}^{MFN}}{\tau_{hijt}^{PRF}}\right)^{\sigma}-1\right)\left(F_{hijt-l}\times U_{t-l}\right)^{-\alpha+\sigma-1}\right]}$$

At any point in time the PRF share today also accounts for the history of shocks. At the steady state, the PRF share does not depends on its history. If tariff did not change for a period long enough – let's call this value 0 – we can take some terms out of the lag sums:

$$s_{hij0}^{PRF} = \left(\frac{\tau_{hj0}^{MFN}}{\tau_{hij0}^{PRF}}\right)^{\sigma}\frac{\left(\tau_{hj0}^{MFN}\right)^{-\sigma\frac{\alpha-\sigma+1}{\sigma-1}}\left(F_{hij0}\right)^{-\alpha+\sigma-1}\sum_{l=0}^{\infty}(1-\psi)^l m_{it-l}\left(B_{jt-l}\right)^{\frac{\alpha-\sigma+1}{\sigma-1}}}{\left(\tau_{hj0}^{MFN}\right)^{-\sigma\frac{\alpha-\sigma+1}{\sigma-1}}\left[1+\left(\left(\frac{\tau_{hj0}^{MFN}}{\tau_{hij0}^{PRF}}\right)^{\sigma}-1\right)\left(F_{hij0}\right)^{-\alpha+\sigma-1}\right]\sum_{l=0}^{\infty}(1-\psi)^l m_{it-l}\left(B_{jt-l}\right)^{\frac{\alpha-\sigma+1}{\sigma-1}}}$$

Then the two lag sums cancel out and we are left with the long run share of PRF exports:

$$s_{hij0}^{PRF} = \frac{\left(\frac{\tau_{hj0}^{MFN}}{\tau_{hij0}^{PRF}}\right)^{\sigma}\left(F_{hij0}\right)^{-\alpha+\sigma-1}}{1+\left(\left(\frac{\tau_{hj0}^{MFN}}{\tau_{hij0}^{PRF}}\right)^{\sigma}-1\right)\left(F_{hij0}\right)^{-\alpha+\sigma-1}} \qquad (32)$$

Note also that we can invert (32) to have measure of $F_{hij0}^{-\alpha+\sigma-1}$:

$$(F_{hij0})^{-\alpha+\sigma-1} = \frac{s_{hij0}^{PRF}}{s_{hij0}^{PRF} + \left(1 - s_{hij0}^{PRF}\right)\left(\frac{\tau_{hj0}^{MFN}}{\tau_{hij0}^{PRF}}\right)^{\sigma}}$$

No deal tariffs

In this section I show how to include the announced no-deal tariffs into the analysis. Consider the risk measure of the PRF model in equation (8). In the main text I maintained the assumption that the tariff distribution is binary, with a probability λ of PRF tariffs and a probability $1-\lambda$ of MFN tariffs. This can be generalised to include another state, the no-deal tariffs. Consider that there is a probability g_{MFN} that future tariffs are drawn from the MFN set, g_{ND} that they come from the no-deal schedule and $g_{PRF} = 1 - g_{MFN} - g_{ND}$ that they remain at the current preferential level, with g_{MFN}, g_{ND}, g_{PRF} <1 and $g_{PRF} + g_{MFN} + g_{ND} = 1$. Then equation (8) can be written as:

$$\omega_{hij}^{PRF} = \frac{(1 - g_{MFN} - g_{ND})\left(\tau_{hij}^{PRF}\right)^{-\sigma} - \left(\tau_{hj}^{MFN}\right)^{-\sigma} + g_{MFN}\left(\tau_{hj}^{MFN}\right)^{-\sigma} + g_{ND}\left(\tau_{hj}^{ND}\right)^{-\sigma}}{\left(\tau_{hij}^{PRF}\right)^{-\sigma} - \left(\tau_{hj}^{MFN}\right)^{-\sigma}} < 1 \tag{33}$$

After rearranging we get:

$$\omega_{hij}^{PRF} = \frac{(1 - g_{MFN})\left[\left(\tau_{hij}^{PRF}\right)^{-\sigma} - \left(\tau_{hj}^{MFN}\right)^{-\sigma}\right] - g_{ND}\left[\left(\tau_{hij}^{PRF}\right)^{-\sigma} - \left(\tau_{hj}^{ND}\right)^{-\sigma}\right]}{\left(\tau_{hij}^{PRF}\right)^{-\sigma} - \left(\tau_{hj}^{MFN}\right)^{-\sigma}}$$

$$\omega_{hij}^{PRF} = (1 - g_{MFN}) - g_{ND}\frac{1 - \left(\tau_{hij}^{PRF}/\tau_{hj}^{ND}\right)^{\sigma}}{1 - \left(\tau_{hij}^{PRF}/\tau_{hj}^{MFN}\right)^{\sigma}} \tag{34}$$

The log-linear approximation of the uncertainty terms is:

$$\frac{\partial \ln X_{hijt}}{\partial \gamma_{t-l}} = -\frac{\alpha - \sigma + 1}{\sigma - 1}\left[1 - \left(\frac{\tau_{hij}^{PRF}}{\tau_{hj}^{MFN}}\right)^{\sigma}\right] s_{hij}^{PRF}(1-\psi)^{l}\,\psi \times \frac{\beta}{1-\beta}\left(1 - \omega_{hij}^{PRF}\right)$$

Substituting the expression of ω_{hij}^{PRF} with no-deal tariffs in (34) and rearranging we have:

$$\frac{\partial \ln X_{hijt}}{\partial \gamma_{t-l}} = -\frac{\alpha-\sigma+1}{\sigma-1} s_{hij}^{PRF} (1-\psi)^l \psi \times \frac{\beta}{1-\beta} \underbrace{g_{MFN} \left[1 - \left(\frac{\tau_{hij}^{PRF}}{\tau_{hj}^{MFN}}\right)^{\sigma}\right]}_{\text{MFN tariff risk}} +$$

$$-\frac{\alpha-\sigma+1}{\sigma-1} s_{hij}^{PRF} (1-\psi)^l \psi \times \frac{\beta}{1-\beta} \underbrace{g_{ND} \left[1 - \left(\frac{\tau_{hij}^{PRF}}{\tau_{hj}^{ND}}\right)^{\sigma}\right]}_{\text{No-deal tariff risk}} \quad (35)$$

Remaining agnostic about the probability weights g_{MFN} and g_{ND} I can take this equation to the data by estimating separate coefficients for the MFN and No-deal tariff risks. This takes us to the empirical equation (24) in the text, with $\omega_{hi} = 1 - \left(\tau_{hi}^{PRF}/\tau_{h}^{MFN}\right)^{\sigma}$ and $\omega_{hi}^{No-Deal} = 1 - \left(\tau_{hi}^{PRF}/\tau_{h}^{ND}\right)^{\sigma}$. Testing the significance of the coefficient on the no-deal tariff risk measure is equivalent to test whether the probability of no-deal tariffs g_{ND} equals zero.

B Data appendix

PTAs and Continuity Agreements information: Information on the PTA partners of the EU comes from the European Union commission website.[17] Information on the UK Continuity Agreements come from the UK government website.[18] For Continuity Agreements I identify two dates as the ones after which uncertainty could start to resolve to construct the CA_{ct} dummy variable in equation (18). First, I review the official CA documents as published by the UK government and press releases to find the dates in which the CAs were signed by each country. For instance, for the CARIFORUM countries the CA, which was presented to Parliament on 22/05/2019, nine out of fourteen countries signed on 22/03/2019 while the remaining five countries signed later on. I believe that the signature date is an accurate measure for the construction of the CA_{ct} dummy.

Second, I consider the month in which the CA was presented to the UK Parliament. Using the month of presentation to Parliament of the CA could introduce some measurement error in the CA_{ct} variable. When a CA covers more than one country, as for the CARIFORUM trade bloc, it is not always the case that all countries covered by the EU PTA signed the CA with the UK in the same period. Moreover, in some instances the CA was presented to Parliament a few months after it had been signed. If the main signal for the reduction of uncertainty was the signature of the deal, then the presentation to Parliament date might consider actually treated periods as non-treated by the CAs, lowering the chances of finding any significant CA effect in the regressions.

[17] See https://ec.europa.eu/trade/policy/countries-and-regions/negotiations-and-agreements/. We consider the agreements in place as per December 2021.

[18] See https://www.gov.uk/guidance/uk-trade-agreements-with-non-eu-countries

For both the signature and presentation to Parliament dates, if the CA date lies in the first half of month t then I set $CA_{ct} = 1$ from month t onwards, while if the CA date lies in the second half of month t I set $CA_{ct} = 1$ from month $t + 1$ onwards.

In total, out of the 70 PTA partners considered, 48 of them signed a Continuity Agreement with the UK in 2019 and to date, only 4 countries did not sign a CA at all.[19] By the end of 2019 the UK signed CAs for a substantial portion of its imports from PTA partners. The two largest `signature months' by imports volume are February 2019, when Switzerland signed, and April 2019 when Iceland and Norway signed.

UK imports data The UK imports dataset includes all EU PTA partners which enjoyed preferential access in 2015 and that now have a trade agreement in place with the EU.[20] Some of these countries had preferential access to the EU market before 2016 under the GSP or EBA schemes, and signed an trade agreement only after 2015, while other countries such as South Africa changed the type of agreement in the period 2015-19. I therefore consider both the full sample, which counts 70 countries, and the restricted sample of countries with PTAs in place before 2013 and that did not change agreement in the period 2013-19. This restricted sample counts 41 countries.

The analysis is carried out at the CN 8-digit product level with monthly frequency using data for 2013-19. Given changes in the CN classification over time, I use the concordance procedure of Van Beveren, Bernard and Vandenbussche (2012).

Data for UK imports from the PTA partners and preference utilisation rates come from the Eurostat Comext database. I use data at the CN 8-digit level with monthly frequency for 2013-19. I exclude imports for inward and outward processing (codes 2 and 3 of the Eurostat Comext statistical regime). These flows concern processing trade and products imported under these regimes are fully or partially exempt from customs duties. Since no duty is levied on these flows, they are not subject from tariff uncertainty.

Data on preference utilisation are available for all EU PTA partner countries at monthly frequency and they cover the totality of EU imports value at the CN 8-digit product level. The PREF dataset gives information on the imports by country, CN 8-digit product, period, statistical

[19]Of of the 70 considered, the actual number of countries without a CA with the UK is 6. However, this includes Andorra and San Marino which are covered by the Trade and Cooperation Agreement (TCA) between the UK and the EU. As reported in the UK government website, under the TCA products originating in Andorra and San Marino `are to be treated as originating in the EU under the UK-EU Trade and Cooperation Agreement as long as Andorra and San Marino apply to UK products the same preferences that the EU applies to them. These products benefit from zero tariffs, where they meet the relevant rules of origin. Trade with Andorra of agricultural products (chapters 01-24) is not in scope of the UK-EU Trade and Cooperation Agreement and takes place under WTO terms.' See: https://www.gov.uk/guidance/uk-trade-agreements-with-non-eu-countries. The four countries that did not sign a continuity agreement are Armenia, Bosnia and Herzegovina, Comoros and Montenegro.

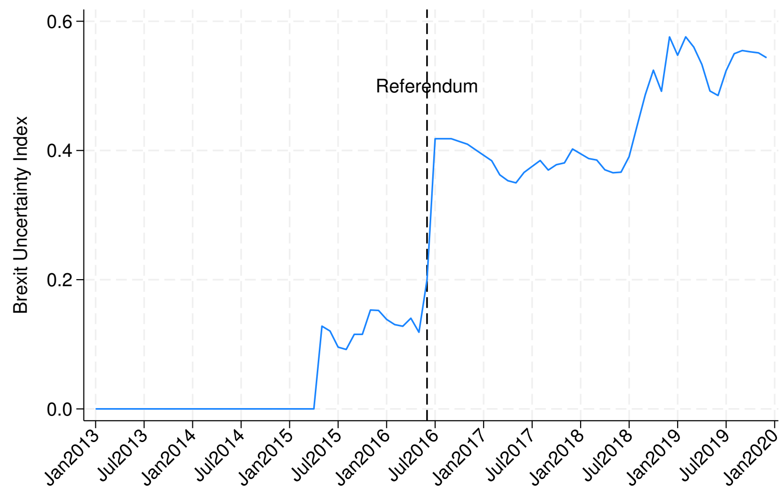
[20]Of the current EU PTA partners, I exclude Canada, Japan, Singapore and Vietnam as they signed trade agreements with the EU after 2015.

regime (Normal trade, processing, not for customs declarations) and import regime. The information required for the calculation of the PRF import share if the import regime. The Eurostat dataset consider the MFN regime, preferential and GSP regimes, and a residual 'unknown' category. The 'unknown' regime accounts for a small fraction of imports: on average over 2013-15, only 3% of total UK imports are classed under the 'unknown' import regime. In the calculation of the PRF share, I drop imports under 'unknown' regime and aggregate the GSP and preferential regimes into a single 'non-MFN' regime for the calculation of the PRF import shares. The baseline PRF shares are computed with data for 2013-15. This is done adding imports over time at the partner-product-regime level (=MFN, PRF), and then compute the PRF share on total imports by partner-product over 2013-15.

Tariff data: MFN and preferential tariff data for the years 2010-19 come from the ITC MacMap database for all countries at the tariff-line level and annual frequency. They are then merged with imports data at the partner-CN8-year level, and they include current and lagged (up to 3 years) tariffs.

Brexit Uncertainty Index: The Brexit Uncertainty Index (BUI) is taken from the Bank of England Decision Maker Panel. This is a large survey of British firms asking what are the major sources of uncertainty, and contains Brexit-specific questions. The index is computed as the proportion of firms citing Brexit as a top-3 source of uncertainty. As the survey started after the referendum in September 2016, the authors of the BUI extrapolated values for the index from August 2016 to May 2015 using betting odds data, and for periods before May 2015 the index takes value of zero. Figure 7 plots the index over the period Jan2013-Dec2019.

Figure 7: Brexit Uncertainty Index



Source: author's elaboration of the Brexit Uncertainty Index.

Table 8: PTA and Continuity Agreements

Country	PTA year	CA Parliament	CA signature	Country	PTA year	CA Parliament	CA signature
Albania	2009	19/02/2021	05/02/2021	El Salvador	2013	06/08/2019	18/07/2019
Algeria	2005			Eswatini	2016	05/11/2019	09/10/2019
Andorra	1991			Faroe Islands	1997	06/02/2019	31/01/2019
Antigua and Barbuda	2008	22/05/2019	06/06/2019	Fiji	2014	20/03/2019	14/03/2019
Armenia	2018			Georgia	2016	04/11/2019	21/10/2019
Bahamas	2008	22/05/2019	27/11/2019	Ghana	2016	20/04/2021	02/03/2021
Barbados	2008	22/05/2019	22/03/2019	Grenada	2008	22/05/2019	22/03/2019
Belize	2008	22/05/2019	22/03/2019	Guatemala	2013	06/08/2019	18/07/2019
Bosnia and Herzegov-ina	2015			Guyana	2008	22/05/2019	22/03/2019
Botswana	2016	05/11/2019	09/10/2019	Honduras	2013	06/08/2019	18/07/2019
Cameroon	2013	20/04/2021	09/03/2021	Iceland	1994	12/04/2019	02/04/2019
Chile	2003	06/02/2019	30/01/2019	Israel	2000	26/02/2019	18/02/2019
Colombia	2013	14/06/2019	15/05/2019	Jamaica	2008	22/05/2019	22/03/2019
Comoros	2019			Jordan	2002	20/12/2019	05/11/2019
Costa Rica	2013	06/08/2019	18/07/2019	Kosovo	2016	20/12/2019	03/12/2019
Cote d'Ivoire	2016	11/11/2020	15/10/2020	Lebanon	2006	22/10/2019	19/09/2019
Dominica	2008	22/05/2019	22/03/2019	Lesotho	2016	05/11/2019	09/10/2019
Dominican Republic	2008	22/05/2019	04/04/2019	Liechtenstein	1995	28/02/2019	11/02/2019
Ecuador	2017	14/06/2019	15/05/2019	Madagascar	2012		
Egypt	2004	14/12/2020	05/12/2020	Mauritius	2012	06/02/2019	31/01/2019

Table 9: PTA and Continuity Agreements continued

Country	PTA year	CA Parliament	CA signature	Country	PTA year	CA Parliament	CA signature
Mexico	2000	26/02/2021	15/12/2020	Serbia	2013	11/05/2021	16/04/2021
Moldova	2016	18/01/2021	24/12/2020	Seychelles	2012	06/02/2019	31/01/2019
Montenegro	2010			Solomon Islands	2020	20/03/2019	22/12/2020
Morocco	2000	20/12/2019	26/10/2019	South Africa	1999	05/11/2019	09/10/2019
Mozambique	2016	05/11/2019	09/10/2019	South Korea	2011	10/09/2019	22/08/2019
Namibia	2016	05/11/2019	09/10/2019	St Kitts and Nevis	2008	22/05/2019	22/03/2019
Nicaragua	2013	06/08/2019	18/07/2019	St Lucia	2008	22/05/2019	22/03/2019
North Macedonia	2004	10/12/2020	03/12/2020	St Vincent and the Grenadines	2008	22/05/2019	22/03/2019
Norway	1994	12/04/2019	02/04/2019	Suriname	2008	22/05/2019	04/03/2021
Palestinian Authority	1997	26/02/2019	18/02/2019	Switzerland	1973	20/02/2019	11/02/2019
Panama	2013	06/08/2019	18/07/2019	Trinidad and Tobago	2008	22/05/2019	01/04/2019
Papua New Guinea	2011	20/03/2019	14/03/2019	Tunisia	1998	25/10/2019	04/10/2019
Peru	2013	14/06/2019	15/05/2019	Turkey	1995	24/02/2021	29/12/2020
Samoa	2018	20/03/2019	22/12/2020	Ukraine	2016	09/11/2020	08/10/2020
San Marino	1991			Zimbabwe	2012	06/02/2019	31/01/2019

C Additional results

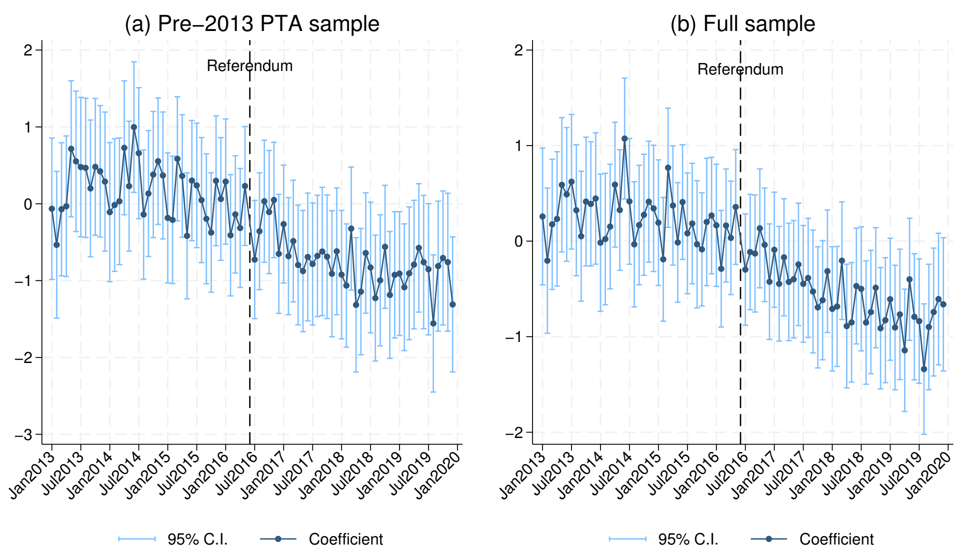
To visually inspect whether there are any pre-referendum trends that might bias the analysis I use an event-study regression:

$$\ln X_{hit} = a_{hi} + a_{ht} + a_{it} + \sum_{t=Jan2013}^{May2016} b_t \left(\omega_{hi} \times s_{hi}^{PRF} \times a_t\right) + \sum_{t=Jul2016}^{Dec2019} b_t \left(\omega_{hi} \times s_{hi}^{PRF} \times a_t\right) + e_{hit} \tag{36}$$

where a_{hi}, a_{ht} and a_{it} are CN8-partner, CN8-time and partner-time fixed effects, and the a_ts are time dummies. The coefficients on the uncertainty measure $\omega_{hi} \times s_{hi}^{PRF}$ are estimated relative to June 2016, the month in which the referendum was held. Compared to the baseline specification of equation (18), the regression model in (36) does not deal with seasonality, but it allows me to see whether we should worry about pre-treatment trends and it is useful to see how the uncertainty effect varied over time.

The coefficient estimates with the 95% confidence interval are plotted in Figure 8 for the pre-2013 PTA sample (panel a) and the full sample (panel b). Overall, there is no sign of pre-referendum trends. On the other hand, I find consistent negative coefficients for the post-referendum period spanning from July 2016 to December 2019. Moreover, there are signs of a negative trend in the treatment effect suggesting that the uncertainty effects have been growing over time. This is in line with the presence of legacy firms and the idea that uncertainty effects build up over time.

Figure 8: Event study plot, UK imports from PTA partners



The figure plots the coefficients of the event-study regression with their 95% confidence interval. For the event-study we regress the log of UK imports from PTA partners at the CN 8-digit level over 2013-19 on the partner-product measure of uncertainty $\omega \times s^{PRF}$ interacted with time dummies. The reference period is June 2016. The regression includes partner-product, partner-time and product-time fixed effects. Standard errors are clustered at the partner-product level.

Table 10: UK vs EU27 imports

	HL model		PRF model	
	(1)	(2)	(3)	(4)
	pre-2013 PTAs	Full sample	pre-2013 PTAs	Full sample
Current tariff	-2.663	-3.318***	-2.692	-2.882*
	(1.713)	(1.157)	(2.388)	(1.510)
Lagged tariff, 1-year	-3.191**	-1.270	-3.596*	-0.738
	(1.616)	(1.282)	(1.944)	(1.489)
Lagged tariff, 2-year	1.489	0.400	1.409	-0.566
	(1.429)	(0.962)	(1.566)	(1.010)
Lagged tariff, 3-year	-1.979*	-1.371*	-1.118	-0.685
	(1.067)	(0.826)	(1.255)	(0.895)
MFN risk, mean 2016	0.284	0.423	-0.307	-0.251
	(0.537)	(0.369)	(0.283)	(0.223)
MFN risk, mean 2017	0.420	0.803**	-0.777**	-0.619**
	(0.527)	(0.368)	(0.307)	(0.247)
MFN risk, mean 2018	-0.733	0.069	-1.298***	-0.969***
	(0.744)	(0.472)	(0.331)	(0.268)
MFN risk, mean 2019	0.166	0.150	-1.015***	-1.042***
	(0.875)	(0.545)	(0.360)	(0.290)
Continuity Agreement	0.074	0.069	-0.012	0.047
	(0.236)	(0.248)	(0.273)	(0.242)
CA+MFN risk	-0.044	0.033	-1.066***	-1.008***
	(0.862)	(0.550)	(0.398)	(0.326)
Partner-product-month FE	Yes	Yes	Yes	Yes
Partner-time FE	Yes	Yes	Yes	Yes
Product-time FE	Yes	Yes	Yes	Yes
Observations	407,980	491,077	404,825	486,072
R2-within	0.0008	0.0006	0.0010	0.0009
AIC	1159148	1427006	1150259	1412893
BIC	1160142	1428172	1151252	1414047

Robust s.e. clustered at partner-CN8 level. * p<0.10, ** p<0.05, *** p<0.01. Columns 1-2 report the estimates based on the Handley Limao model. Columns 3-4 are based on the PRF model. In columns 1-2 the tariff is the preferential tariff, while in columns 3-4 it is the weighted-average applied tariff $s^{PRF} \ln \tau^{PRF} + s^{MFN} \ln \tau^{MFN}$. The dependent variable is the difference between log of UK and the log of EU imports from PTA partners excluding processing trade. Uncertainty coefficients are estimated for each period between Jan2016-Dec2019, and year averages are reported. CA effects are computed for each cohort-period, and the average of all cohort-period effects is reported. For the HL model, MFN uncertainty is measured as $\omega = 1 - (\tau^{PRF}/\tau^{MFN})^{\sigma}$ with $\sigma = 4$ while no-deal tariffs uncertainty is measured using the no-deal rather than MFN tariffs in ω. For the PRF model the uncertainty measure is the one of the HL model multiplied by the PRF share $\omega \times s^{PRF}$. The term 'CA+MFN risk' tests whether the sum of the average CA and the average uncertainty effects in Feb2019-Dec2019 is equal to zero. The term 'CA+No deal tariff risk' tests whether the sum of the average CA no-deal and the average no-deal uncertainty effects in Mar2019-Dec2019 is equal to zero.

Table 11: No-deal tariffs

	HL model		PRF model	
	(1)	(2)	(3)	(4)
	pre-2013 PTAs	Full sample	pre-2013 PTAs	Full sample
Current tariff	-2.141**	-1.581**	-3.163**	-1.747*
	(1.010)	(0.758)	(1.439)	(0.978)
Lagged tariff, 1-year	-1.366*	-1.617**	-1.373	-1.153
	(0.829)	(0.639)	(1.091)	(0.744)
Lagged tariff, 2-year	0.411	0.107	0.613	0.048
	(0.868)	(0.638)	(0.987)	(0.706)
Lagged tariff, 3-year	-0.656	-0.041	-0.582	0.072
	(0.733)	(0.572)	(0.906)	(0.658)
MFN risk, mean 2016	0.003	0.171	-0.361*	-0.236
	(0.350)	(0.225)	(0.189)	(0.144)
MFN risk, mean 2017	0.798*	0.472	-0.844***	-0.594***
	(0.425)	(0.293)	(0.225)	(0.175)
MFN risk, mean 2018	0.396	0.200	-1.243***	-0.982***
	(0.560)	(0.352)	(0.241)	(0.187)
MFN risk, mean 2019	1.074	0.176	-1.411***	-1.208***
	(0.727)	(0.495)	(0.283)	(0.223)
No-deal tariff risk, mean 2019	-0.464*	-0.291**	0.444	-0.213
	(0.255)	(0.140)	(0.509)	(0.359)
Continuity Agreement	-1.100***	-0.900***	0.401*	0.330*
	(0.388)	(0.313)	(0.209)	(0.186)
Cont. Agreement No-deal tariffs	0.410	0.171	0.291	-0.201
	(0.357)	(0.264)	(0.454)	(0.318)
CA+MFN risk 2019	-0.089	-0.800	-1.072***	-0.919***
	(0.790)	(0.563)	(0.305)	(0.252)
CA+No-deal tariff risk	-0.053	-0.120	0.735	-0.413
	(0.424)	(0.288)	(0.616)	(0.414)
Partner-product-month FE	Yes	Yes	Yes	Yes
Partner-time FE	Yes	Yes	Yes	Yes
Product-time FE	Yes	Yes	Yes	Yes
Observations	451,017	559,167	445,253	549,863
R2-within	0.0011	0.0009	0.0017	0.0014
AIC	1067905	1329851	1056093	1310475
BIC	1069448	1331728	1057623	1312326

Robust s.e. clustered at partner-CN8 level. * p<0.10, ** p<0.05, *** p<0.01. Columns 1-2 report the estimates based on the Handley Limao model. Columns 3-4 are based on the PRF model. In columns 1-2 the tariff is the preferential tariff, while in columns 3-4 it is the weighted-average applied tariff $s^{PRF}\ln\tau^{PRF}+s^{MFN}\ln\tau^{MFN}$. The dependent variable is the log of UK imports from PTA partners excluding processing trade. Uncertainty coefficients are estimated for each period between Jan2016-Dec2019, and year averages are reported. CA effects are computed for each cohort-period, and the average of all cohort-period effects is reported. For the HL model, uncertainty is measured as $\omega = 1-(\tau^{PRF}/\tau^{MFN})^{\sigma}$ with $\sigma = 4$. For the PRF model the uncertainty measure is the one of the HL model multiplied by the PRF share $\omega \times s^{PRF}$. The term 'CA+MFN risk' tests whether the sum of the average CA and the average uncertainty effects in Feb2019-Dec2019 is equal to zero.

Table 12: Excluding synthetic products

	HL model		PRF model	
	(1)	(2)	(3)	(4)
	pre-2013 PTAs	Full sample	pre-2013 PTAs	Full sample
Current tariff	-2.740*	-1.732	-4.684**	-1.854
	(1.506)	(1.179)	(2.207)	(1.505)
Lagged tariff, 1-year	-1.343	-0.990	-0.915	-0.347
	(1.289)	(0.872)	(1.644)	(1.094)
Lagged tariff, 2-year	0.348	-0.402	1.177	-0.680
	(1.198)	(0.875)	(1.479)	(0.979)
Lagged tariff, 3-year	-0.633	-0.172	-0.496	-0.174
	(0.823)	(0.697)	(1.088)	(0.847)
MFN risk, mean 2016	0.406	0.185	-0.366*	-0.326**
	(0.370)	(0.266)	(0.207)	(0.164)
MFN risk, mean 2017	1.046*	0.628*	-0.932***	-0.733***
	(0.538)	(0.374)	(0.241)	(0.195)
MFN risk, mean 2018	0.540	0.176	-1.421***	-1.165***
	(0.811)	(0.513)	(0.265)	(0.211)
MFN risk, mean 2019	0.942	0.028	-1.686***	-1.503***
	(0.956)	(0.652)	(0.299)	(0.238)
Continuity Agreement	-0.460	-0.293	0.659***	0.528***
	(0.376)	(0.307)	(0.232)	(0.198)
CA+MFN risk	0.302	-0.421	-1.120***	-1.036***
	(0.994)	(0.687)	(0.337)	(0.266)
Partner-product-month FE	Yes	Yes	Yes	Yes
Partner-time FE	Yes	Yes	Yes	Yes
Product-time FE	Yes	Yes	Yes	Yes
Observations	381,585	468,114	376,547	460,138
R2-within	0.0011	0.0008	0.0019	0.0015
AIC	902338	1111002	891888	1094292
BIC	903336	1112174	892875	1095441

Robust s.e. clustered at partner-CN8 level. * p<0.10, ** p<0.05, *** p<0.01. Columns 1-2 report the estimates based on the Handley Limao model. Columns 3-4 are based on the PRF model. In columns 1-2 the tariff is the preferential tariff, while in columns 3-4 it is the weighted-average applied tariff $s^{PRF} \ln \tau^{PRF} + s^{MFN} \ln \tau^{MFN}$. The dependent variable is the log of UK imports from PTA partners excluding processing trade. Uncertainty coefficients are estimated for each period between Jan2016-Dec2019, and year averages are reported. CA effects are computed for each cohort-period, and the average of all cohort-period effects is reported. For the HL model, uncertainty is measured as $\omega = 1 - (\tau^{PRF}/\tau^{MFN})^{\sigma}$ with $\sigma = 4$. For the PRF model the uncertainty measure is the one of the HL model multiplied by the PRF share $\omega \times s^{PRF}$. The term `CA+MFN risk' tests whether the sum of the average CA and the average uncertainty effects in Feb2019-Dec2019 is equal to zero. Compared to the baseline specification, the sample used for this table exclude `synthetic' products for which codes split and merge over time.

Table 13: Including processing trade

	HL model		PRF model	
	(1)	(2)	(3)	(4)
	pre-2013 PTAs	Full sample	pre-2013 PTAs	Full sample
Current tariff	-1.689*	-1.360*	-2.477*	-1.272
	(0.958)	(0.743)	(1.396)	(0.980)
Lagged tariff, 1-year	-1.037	-1.220*	-0.872	-0.749
	(0.792)	(0.623)	(1.060)	(0.742)
Lagged tariff, 2-year	0.732	0.311	0.787	0.015
	(0.877)	(0.652)	(0.978)	(0.712)
Lagged tariff, 3-year	-0.666	-0.038	-0.630	-0.104
	(0.721)	(0.557)	(0.888)	(0.644)
MFN risk, mean 2016	0.042	0.152	-0.374**	-0.203
	(0.339)	(0.221)	(0.182)	(0.140)
MFN risk, mean 2017	0.791*	0.445	-0.725***	-0.473***
	(0.416)	(0.289)	(0.222)	(0.171)
MFN risk, mean 2018	0.426	0.185	-1.189***	-0.932***
	(0.547)	(0.344)	(0.237)	(0.185)
MFN risk, mean 2019	0.985	-0.130	-1.379***	-1.234***
	(0.681)	(0.434)	(0.266)	(0.206)
Continuity Agreement	-0.939***	-0.718**	0.456**	0.356**
	(0.349)	(0.291)	(0.196)	(0.167)
CA+MFN risk	-0.025	-0.952*	-0.979***	-0.927***
	(0.731)	(0.494)	(0.284)	(0.223)
Partner-product-month FE	Yes	Yes	Yes	Yes
Partner-time FE	Yes	Yes	Yes	Yes
Product-time FE	Yes	Yes	Yes	Yes
Observations	451,130	559,300	445,728	550,514
R2-within	0.0009	0.0007	0.0014	0.0012
AIC	1065912	1327743	1054971	1309608
BIC	1066925	1328934	1055973	1310775

Robust s.e. clustered at partner-CN8 level. * p<0.10, ** p<0.05, *** p<0.01. Columns 1-2 report the estimates based on the Handley Limao model. Columns 3-4 are based on the PRF model. In columns 1-2 the tariff is the preferential tariff, while in columns 3-4 it is the weighted-average applied tariff $s^{PRF} \ln \tau^{PRF} + s^{MFN} \ln \tau^{MFN}$. The dependent variable is the log of UK imports from PTA partners including processing trade. Uncertainty coefficients are estimated for each period between Jan2016-Dec2019, and year averages are reported. CA effects are computed for each cohort-period, and the average of all cohort-period effects is reported. For the HL model, uncertainty is measured as $\omega = 1 - (\tau^{PRF}/\tau^{MFN})^{\sigma}$ with $\sigma = 4$. For the PRF model the uncertainty measure is the one of the HL model multiplied by the PRF share $\omega \times s^{PRF}$. The term 'CA+MFN risk' tests whether the sum of the average CA and the average uncertainty effects in Feb2019-Dec2019 is equal to zero.

Table 14: Presentation to Parliament for CA date

	HL model		PRF model	
	(1)	(2)	(3)	(4)
	pre-2013 PTAs	Full sample	pre-2013 PTAs	Full sample
Current tariff	-2.037**	-1.704**	-3.157**	-1.791*
	(1.002)	(0.757)	(1.440)	(0.973)
Lagged tariff, 1-year	-1.361	-1.556**	-1.374	-1.100
	(0.829)	(0.632)	(1.094)	(0.743)
Lagged tariff, 2-year	0.477	0.180	0.693	0.155
	(0.865)	(0.641)	(0.979)	(0.713)
Lagged tariff, 3-year	-0.714	-0.149	-0.715	-0.078
	(0.724)	(0.564)	(0.890)	(0.645)
MFN risk, mean 2016	-0.011	0.170	-0.365*	-0.234
	(0.345)	(0.224)	(0.189)	(0.144)
MFN risk, mean 2017	0.787*	0.479	-0.847***	-0.594***
	(0.425)	(0.293)	(0.225)	(0.175)
MFN risk, mean 2018	0.366	0.189	-1.247***	-0.983***
	(0.558)	(0.349)	(0.241)	(0.187)
MFN risk, mean 2019	0.921	-0.142	-1.324***	-1.226***
	(0.682)	(0.431)	(0.268)	(0.208)
Continuity Agreement	0.434**	0.294*	0.265	0.113
	(0.213)	(0.171)	(0.246)	(0.197)
CA+MFN risk	1.278*	0.045	-1.113***	-1.156***
	(0.665)	(0.426)	(0.321)	(0.249)
Partner-product-month FE	Yes	Yes	Yes	Yes
Partner-time FE	Yes	Yes	Yes	Yes
Product-time FE	Yes	Yes	Yes	Yes
Observations	451,130	559,300	445,367	549,992
R2-within	0.0008	0.0006	0.0015	0.0013
AIC	1068173	1330159	1056348	1310747
BIC	1069220	1331283	1057394	1311869

Robust s.e. clustered at partner-CN8 level. * p<0.10, ** p<0.05, *** p<0.01. Columns 1-2 report the estimates based on the Handley Limao model. Columns 3-4 are based on the PRF model. In columns 1-2 the tariff is the preferential tariff, while in columns 3-4 it is the weighted-average applied tariff $s^{PRF} \ln \tau^{PRF} + s^{MFN} \ln \tau^{MFN}$. The dependent variable is the log of UK imports from PTA partners excluding processing trade. Uncertainty coefficients are estimated for each period between Jan2016-Dec2019, and year averages are reported. CA effects are computed for each cohort-period, and the average of all cohort-period effects is reported. For the HL model, uncertainty is measured as $\omega = 1 - (\tau^{PRF}/\tau^{MFN})^{\sigma}$ with $\sigma = 4$. For the PRF model the uncertainty measure is the one of the HL model multiplied by the PRF share $\omega \times s^{PRF}$. The term 'CA+MFN risk' tests whether the sum of the average CA and the average uncertainty effects in Feb2019-Dec2019 is equal to zero. Compared to other specifications, the CA dummies are based on the date in which the CAs were presented to the UK Parliament rather than the signature date.

Table 15: HL model, different product-time fixed effects

	(1)	(2)	(3)	(4)	(5)
Current tariff	-0.987**	-0.904*	-1.118**	-1.226*	-1.764**
	(0.446)	(0.476)	(0.562)	(0.689)	(0.787)
Lagged tariff, 1-year	-0.736**	-0.671*	-0.904**	-1.125**	-1.804***
	(0.359)	(0.377)	(0.394)	(0.473)	(0.647)
Lagged tariff, 2-year	-0.375	0.067	-0.010	-0.316	0.067
	(0.330)	(0.338)	(0.424)	(0.516)	(0.649)
Lagged tariff, 3-year	-0.180	-0.063	-0.264	-0.242	-0.285
	(0.311)	(0.314)	(0.390)	(0.490)	(0.570)
MFN risk, 2016	-0.047	0.129	0.039	0.094	0.181
	(0.053)	(0.083)	(0.113)	(0.154)	(0.232)
MFN risk, 2017	-0.182***	0.074	0.039	0.232	0.542*
	(0.063)	(0.096)	(0.133)	(0.177)	(0.291)
MFN risk, 2018	-0.345***	0.031	0.054	0.159	0.329
	(0.070)	(0.108)	(0.150)	(0.206)	(0.357)
MFN risk, 2019	-0.478***	-0.254**	-0.247	-0.161	0.072
	(0.086)	(0.127)	(0.175)	(0.241)	(0.442)
Continuity Agreement	0.449***	0.394***	0.406***	0.376***	0.414***
	(0.099)	(0.105)	(0.114)	(0.127)	(0.137)
Observations	705,284	705,180	680,610	609,345	549,537
Partner-CN8-month FE	Yes	Yes	Yes	Yes	Yes
Partner-time FE	Yes	Yes	Yes	Yes	Yes
Product-time FE		HS2	HS4	HS6	CN8

Robust s.e. clustered at partner-CN8 level. * p<0.10, ** p<0.05, *** p<0.01. The table reports estimates based on the Handley Limao model with fixed effects at different product-time level. Column 1 does not include product-time FE. For the other columns the levels are: column 2 at the HS 2-digit, column 3 at the HS 4-digit, column 4 at the HS 6-digit and column 5 at CN 8-digit level. The dependent variable is the log of UK imports from PTA partners excluding processing trade. The tariff is the preferential tariff. Uncertainty coefficients are estimated for each year between 2016-2019. The CA effect is computed interacting the uncertainty measure with a dummy for the Continuity Agreements. Uncertainty is measured as $\omega = 1 - (\tau^{PRF}/\tau^{MFN})^{\sigma}$ with $\sigma = 4$.

Table 16: PRF model, different product-time fixed effects

	(1)	(2)	(3)	(4)	(5)
Current tariff	-1.285***	-1.111**	-1.692***	-1.739**	-1.811*
	(0.491)	(0.517)	(0.652)	(0.852)	(0.997)
Lagged tariff, 1-year	-0.678*	-0.625*	-0.852**	-0.741	-1.260*
	(0.366)	(0.377)	(0.399)	(0.487)	(0.756)
Lagged tariff, 2-year	-0.506*	-0.126	-0.065	-0.246	0.112
	(0.303)	(0.299)	(0.362)	(0.441)	(0.720)
Lagged tariff, 3-year	-0.168	-0.026	-0.157	0.128	-0.127
	(0.320)	(0.323)	(0.411)	(0.500)	(0.649)
MFN risk, 2016	-0.112**	-0.068	-0.174*	-0.136	-0.258*
	(0.055)	(0.076)	(0.095)	(0.118)	(0.147)
MFN risk, 2017	-0.315***	-0.275***	-0.402***	-0.371***	-0.657***
	(0.065)	(0.089)	(0.111)	(0.136)	(0.177)
MFN risk, 2018	-0.494***	-0.382***	-0.538***	-0.615***	-1.039***
	(0.073)	(0.100)	(0.121)	(0.150)	(0.190)
MFN risk, 2019	-0.670***	-0.716***	-0.862***	-0.906***	-1.230***
	(0.091)	(0.120)	(0.144)	(0.177)	(0.211)
Continuity Agreement	0.414***	0.383***	0.430***	0.381***	0.386**
	(0.110)	(0.115)	(0.125)	(0.139)	(0.150)
Observations	693,985	693,881	669,588	599,264	540,302
Partner-CN8-month FE	Yes	Yes	Yes	Yes	Yes
Partner-time FE	Yes	Yes	Yes	Yes	Yes
Product-time FE		HS2	HS4	HS6	CN8

Robust s.e. clustered at partner-CN8 level. * p<0.10, ** p<0.05, *** p<0.01. The table reports estimates based on the Handley Limao model with fixed effects at different product-time level. Column 1 does not include product-time FE. For the other columns the levels are: column 2 at the HS 2-digit, column 3 at the HS 4-digit, column 4 at the HS 6-digit and column 5 at CN 8-digit level. The dependent variable is the log of UK imports from PTA partners excluding processing trade (full sample). The tariff is the weighted-average applied tariff $s^{PRF} \ln \tau^{PRF} + s^{MFN} \ln \tau^{MFN}$. Uncertainty coefficients are estimated for each year between 2016-2019.The CA effect is computed interacting the uncertainty measure with a dummy for the Continuity Agreements. Uncertainty is measured as $s^{PRF} \times \omega$, where $\omega = 1 - (\tau^{PRF}/\tau^{MFN})^{\sigma}$, $\sigma = 4$ and s^{PRF} is the share of PRF imports over 2013-15.

Table 17: GHL sample, HL model and Brexit Uncertainty Index

	(1)	(2)	(3)	(4)	(5)
MFN risk × Uncertainty index	-1.059***	-0.384	-0.243	-0.328	1.957
	(0.196)	(0.313)	(0.492)	(0.698)	(1.934)
CA × MFN risk × Uncertainty index	0.930***	0.837***	1.094***	0.998***	1.268***
	(0.200)	(0.239)	(0.281)	(0.327)	(0.371)
Tariffs, lags 0-3	Yes	Yes	Yes	Yes	Yes
Observations	519,591	519,146	492,469	418,990	360,092
Partner-CN8-month FE	Yes	Yes	Yes	Yes	Yes
Partner-time FE	Yes	Yes	Yes	Yes	Yes
Product-time FE		HS2	HS4	HS6	CN8

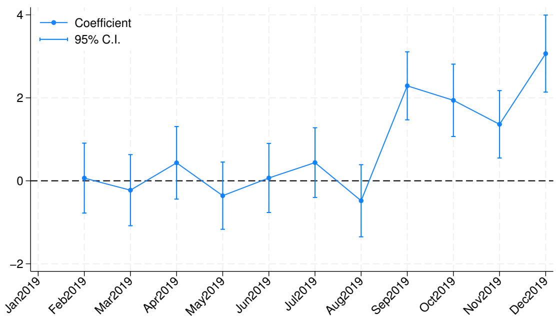
Robust s.e. clustered at partner-CN8 level. * p<0.10, ** p<0.05, *** p<0.01. The table reports estimates based on the Handley Limao model using the sample of PTA countries of Graziano, Handley and Limão (2020): Iceland, Norway, Switzerland, Turkey, Mexico, Israel, Chile and South Korea. The dependent variable is the log of UK imports excluding processing trade. The results are based on the estimation of model (23) where the tail risk $\omega = 1 - (\tau^{PRF}/\tau^{MFN})^{\sigma}$ is interacted with the log of the Brexit Uncertainty Index. To deal with zeros in the BUI, I take the hyperbolic sine transformation $\ln[x + (1 + x^2)^{0.5}]$. The model include the interaction of the MFN risk, the current and up to two lags of the log of the BUI. The table reports the sum of the coefficients on the current and all lagged values interactions of BUI and the MFN risk. For Continuity Agreements, the MFN risk and BUI are interacted with a dummy for CA signature. Current and lagged preferential tariffs are included. Columns differ in terms of product-time fixed effects. Column 1 does not include product-time FE. For the other columns the levels are: column 2 at the HS 2-digit, column 3 at the HS 4-digit, column 4 at the HS 6-digit and column 5 at CN 8-digit level.

Table 18: GHL sample, PRF model and Brexit Uncertainty Index

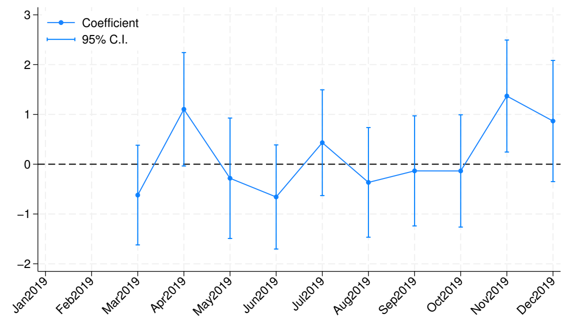
	(1)	(2)	(3)	(4)	(5)
MFN risk × Uncertainty index	-1.556***	-1.514***	-2.071***	-2.244***	-3.239***
	(0.211)	(0.299)	(0.391)	(0.504)	(0.633)
CA × MFN risk × Uncertainty index	0.919***	0.881***	1.214***	1.126***	1.405***
	(0.225)	(0.260)	(0.304)	(0.357)	(0.405)
Tariffs, lags 0-3	Yes	Yes	Yes	Yes	Yes
Observations	514,947	514,488	488,098	415,420	357,312
Partner-CN8-month FE	Yes	Yes	Yes	Yes	Yes
Partner-time FE	Yes	Yes	Yes	Yes	Yes
Product-time FE		HS2	HS4	HS6	CN8

Robust s.e. clustered at partner-CN8 level. * p<0.10, ** p<0.05, *** p<0.01. The table reports estimates based on the PRF model using the sample of PTA countries of Graziano, Handley and Limão (2020): Iceland, Norway, Switzerland, Turkey, Mexico, Israel, Chile and South Korea. The dependent variable is the log of UK imports excluding processing trade. The results are based on the estimation of model (23) where the tail risk $\omega = 1 - (\tau^{PRF}/\tau^{MFN})^{\sigma}$ is interacted with the share of PRF imports and the log of the Brexit Uncertainty Index. To deal with zeros in the BUI, I take the hyperbolic sine transformation $\ln[x + (1 + x^2)^{0.5}]$. The model include the interaction of the MFN risk, the current and up to two lags of the log of the BUI. The table reports the sum of the coefficients on the current and all lagged values interactions of BUI and the MFN risk. For Continuity Agreements, the MFN risk and the BUI are interacted with a dummy for CA signature. Current and lagged average applied tariffs are included. Columns differ in terms of product-time fixed effects. Column 1 does not include product-time FE. For the other columns the levels are: column 2 at the HS 2-digit, column 3 at the HS 4-digit, column 4 at the HS 6-digit and column 5 at CN 8-digit level.

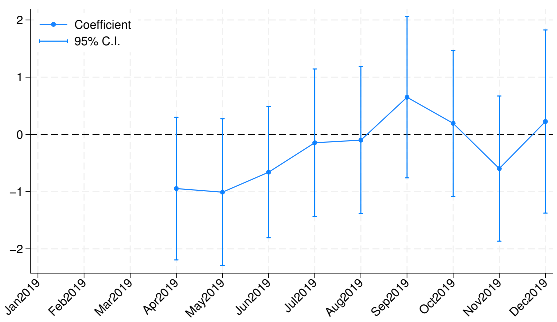
Figure 9: Cohort-time treatment effects of Continuity Agreements



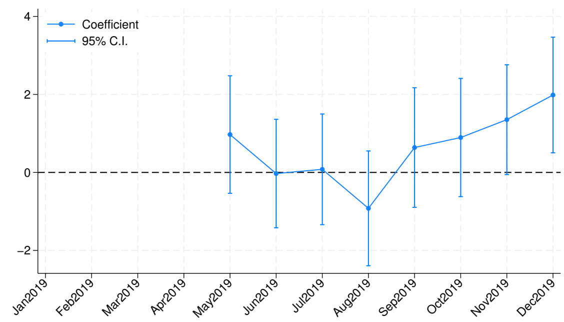
(a) Cohort February 2019



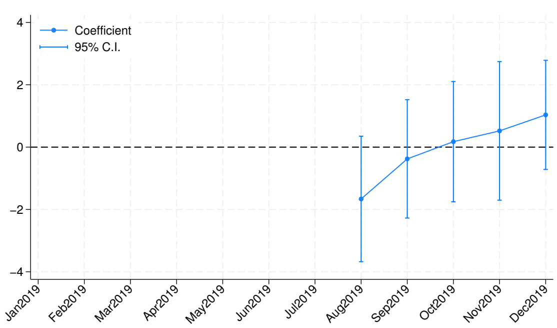
(b) Cohort March 2019



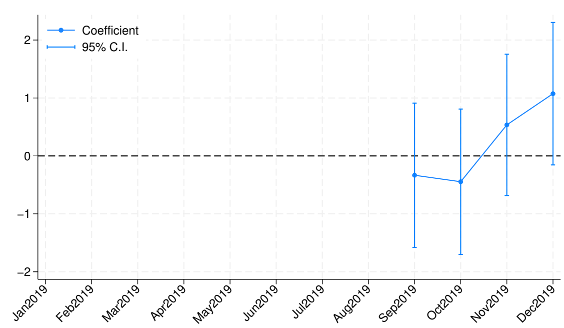
(c) Cohort April 2019



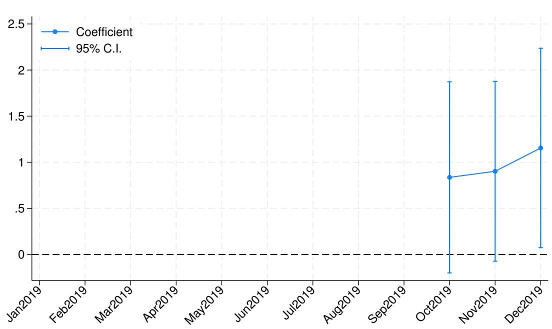
(d) Cohort May 2019



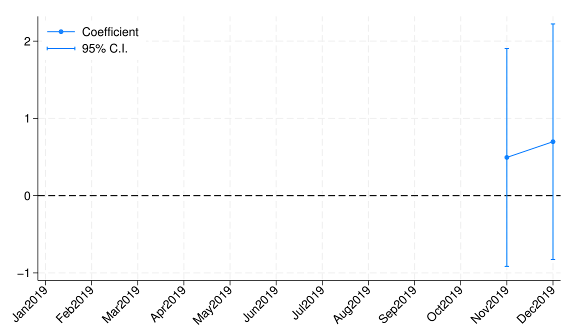
(e) Cohort August 2019



(f) Cohort Sptember 2019



(g) Cohort October 2019



(h) Cohort November 2019

The figure reports the 2019 uncertainty coefficients, the CA effects by cohort-time, together with their 95% confidence interval. Results from the full sample baseline estimation.

C.1 Reduced IV regressions

This section reports the IV regressions without dealing with staggered adoption and estimating one uncertainty coefficient for each year rather than for each year-month. This is done to report first-stage regressions in a compact way and to provide F statistics for the first stage for all specifications. I estimate these regressions for the full sample only. For Continuity Agreements, I interact the MFN risk with a dummy that equals one if the country signed a CA in period t and zero otherwise.

Table 19 reports the second-stage regressions. In all cases we can see that F-stats are very large. The first-stage regressions are reported in Tables 20-23. Each columns represents a first-stage for a given endogenous variable and the relevant instrument can be found on the diagonal. We can see that the relevant instruments are always strongly significant and have coefficients close to unity.

Table 19: Reduced IV regression, second stage

	Instrumented variable			
	(1)	(2)	(3)	(4)
	PRF share 13-15	Tariff margin	PRF share 13-19	shr 13-19; tariff mrg
Current tariff	-2.263***	-1.532**	-2.448***	-1.929**
	(0.757)	(0.682)	(0.742)	(0.750)
Lagged tariff, 1-year	-1.539**	-0.813	-1.645**	-1.034
	(0.688)	(0.623)	(0.662)	(0.669)
Lagged tariff, 2-year	0.430	0.236	0.331	0.497
	(0.620)	(0.543)	(0.594)	(0.598)
Lagged tariff, 3-year	0.011	-0.056	0.013	0.074
	(0.486)	(0.408)	(0.457)	(0.459)
MFN risk, 2016	-0.405**	-0.447***	-0.431***	-0.969***
	(0.160)	(0.121)	(0.159)	(0.213)
MFN risk, 2017	-0.422***	-0.877***	-0.425***	-1.033***
	(0.158)	(0.120)	(0.155)	(0.206)
MFN risk, 2018	-0.926***	-1.486***	-0.852***	-1.700***
	(0.159)	(0.122)	(0.155)	(0.208)
MFN risk, 2019	-1.182***	-1.599***	-1.223***	-1.911***
	(0.164)	(0.129)	(0.161)	(0.211)
Continuity Agreement	0.490***	0.753***	0.473***	0.954***
	(0.109)	(0.128)	(0.107)	(0.145)
Partner-product-month FE	Yes	Yes	Yes	Yes
Partner-time FE	Yes	Yes	Yes	Yes
Product-time FE	Yes	Yes	Yes	Yes
Observations	545,938	549,992	554,734	554,734
F frist-stage	21,095.9	80,672.5	26,701.5	10,710.9

Robust s.e. clustered at partner-CN8 level. * p<0.10, ** p<0.05, *** p<0.01. Columns 1 instruments the UK PRF share 2013-15 with the EU PRF share 2013-19. Column 2 instruments the tariff margin with the median margin computed with MFN tariffs of Australia, Canada, Japan and the US. Column 3 instruments the UK PRF share 2013-19 with the EU share 2013-19. Column 4 instruments both the UK share 2013-19 and the tariff margin. The dependent variable is the log of UK and EU imports from PTA partners excluding processing trade.

Table 20: Reduced IV PRF share 2013-15, first stage

	Tariff				MFN risk				
	lag=0	lag=1	lag=2	lag=3	2016	2017	2018	2019	Cont. Ag.
Tariff IV, lag=0	0.908***	-0.038***	-0.015***	-0.016***	0.045***	0.097***	-0.003	0.050***	0.036***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.011)	(0.011)	(0.011)	(0.011)	(0.007)
Tariff IV, lag=1	-0.022***	0.904***	-0.046***	-0.027***	0.100***	0.078***	0.084***	0.006	0.002
	(0.001)	(0.001)	(0.001)	(0.002)	(0.010)	(0.010)	(0.010)	(0.010)	(0.006)
Tariff IV, lag=2	-0.005***	-0.032***	0.895***	-0.015***	0.041***	0.051***	0.040***	0.081***	0.041***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.009)	(0.009)	(0.009)	(0.009)	(0.006)
Tariff IV, lag=3	-0.000	-0.008***	-0.016***	0.861***	-0.077***	0.033***	0.097***	0.117***	0.042***
	(0.000)	(0.001)	(0.001)	(0.001)	(0.007)	(0.007)	(0.007)	(0.007)	(0.004)
MFN risk IV, 2016	-0.002***	0.000***	0.002***	0.003***	0.717***	-0.007***	-0.003*	-0.004**	-0.002*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)
MFN risk IV, 2017	-0.002***	-0.000*	0.001***	0.002***	-0.012***	0.726***	-0.003	-0.005***	-0.003**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)
MFN risk IV, 2018	-0.003***	-0.001***	0.000**	0.004***	-0.012***	-0.009***	0.731***	-0.006***	-0.002**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)
MFN risk IV, 2019	-0.003***	-0.002***	-0.000	0.004***	-0.013***	-0.012***	-0.008***	0.740***	-0.086***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)
Cont. Ag. IV	0.000***	0.000	-0.000	-0.001***	0.001	0.002	0.002	-0.008***	0.939***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)
Observations	545,938	545,938	545,938	545,938	545,938	545,938	545,938	545,938	545,938
Partner-CN8-month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Partner-time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CN8-time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust s.e. clustered at partner-CN8 level. * p<0.10, ** p<0.05, *** p<0.01. The table reports the first stages using the EU PRF share to instrument the UK PRF share 2013-15. In columns 1-4 the dependent variable is the average applied tariff computed as $\ln \tau_{hit} = s_{hi}^{PRF} \ln \tau_{hit}^{PRF} + s_{hi}^{MFN} \ln \tau_{ht}^{MFN}$. In columns 5-8 the dependent variable is the MFN risk computed as $s_{hi}^{PRF} \times \omega_{hi}$, where $\omega_{hi} = 1 - (\tau_{hi}^{PRF}/\tau_{h}^{MFN})^{\sigma}$ with $\sigma = 4$. In column 9 the dependent variable is the interaction of the Continuity Agreement dummy with the MFN risk.

Table 21: Reduced IV tariff margin, first stage

	(1) MFN risk, 2016	(2) MFN risk, 2017	(3) MFN risk, 2018	(4) MFN risk, 2019	(5) Cont. Ag.
MFN risk IV, 2016	1.102***	-0.000	0.001	-0.002	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
MFN risk IV, 2017	-0.001	1.113***	-0.003*	-0.004***	-0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
MFN risk IV, 2018	0.000	-0.004**	1.117***	-0.006***	-0.003*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
MFN risk IV, 2019	0.000	-0.001	-0.003*	1.110***	0.060***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Continuity Agreement IV	0.001	0.004***	0.003*	-0.012***	0.955***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Tariff, lag=0	0.294***	0.229***	-0.025***	0.245***	0.170***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.009)
Tariff, lag=2	0.121***	0.273***	0.261***	-0.001	0.014*
	(0.007)	(0.007)	(0.007)	(0.007)	(0.008)
Tariff, lag=2	-0.345***	0.034***	0.166***	0.212***	0.155***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.007)
Tariff, lag=3	0.017***	-0.219***	-0.008*	0.103***	0.029***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Observations	549,992	549,992	549,992	549,992	549,992
Partner-CN8-month FE	Yes	Yes	Yes	Yes	Yes
Partner-time FE	Yes	Yes	Yes	Yes	Yes
CN8-time FE	Yes	Yes	Yes	Yes	Yes

Robust s.e. clustered at partner-CN8 level. * p<0.10, ** p<0.05, *** p<0.01. The table reports the first stages using median of the tail risk computed with the MFN tariffs of the Australia, Canada, Japan and the US to instrument the UK tail risk. In columns 1-4 the dependent variable is the MFN risk computed as $s_{hi}^{PRF} \times \omega_{hi}$, where $\omega_{hi} = 1 - (\tau_{hi}^{PRF}/\tau_h^{MFN})^\sigma$ with $\sigma = 4$. In column 5 the dependent variable is the interaction of the Continuity Agreement dummy with the MFN risk.

Table 22: Reduced IV PRF share 2013-19, first stage

	Tariff				MFN risk				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	lag=0	lag=1	lag=2	lag=3	2016	2017	2018	2019	Cont. Ag.
Tariff IV, lag=0	0.922***	-0.029***	-0.010***	-0.010***	0.042***	0.093***	-0.016	0.040***	0.022***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.010)	(0.010)	(0.010)	(0.009)	(0.006)
Tariff IV, lag=1	-0.020***	0.931***	-0.032***	-0.014***	0.083***	0.061***	0.080***	0.001	0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.009)	(0.009)	(0.009)	(0.009)	(0.005)
Tariff IV, lag=2	-0.002***	-0.021***	0.932***	-0.006***	-0.011	0.043***	0.028***	0.080***	0.035***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.008)	(0.008)	(0.008)	(0.008)	(0.005)
Tariff IV, lag=3	0.002***	-0.001*	-0.006***	0.909***	-0.034***	-0.010	0.073***	0.077***	0.026***
	(0.000)	(0.000)	(0.001)	(0.001)	(0.006)	(0.006)	(0.006)	(0.006)	(0.004)
MFN risk IV, 2016	-0.002***	0.000***	0.002***	0.003***	0.712***	-0.004***	-0.001	-0.003*	-0.002**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)
MFN risk IV, 2017	-0.001***	-0.001***	0.001***	0.003***	-0.010***	0.730***	-0.003*	-0.005***	-0.002**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)
MFN risk IV, 2018	-0.002***	-0.001***	0.000	0.004***	-0.009***	-0.006***	0.731***	-0.006***	-0.004***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)
MFN risk IV, 2019	-0.002***	-0.001***	0.000	0.003***	-0.012***	-0.009***	-0.008***	0.744***	-0.078***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)
Cont. Ag. IV	0.001***	0.001***	0.000*	-0.000*	0.003**	0.005***	0.003*	-0.021***	0.939***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Observations	554,734	554,734	554,734	554,734	554,734	554,734	554,734	554,734	554,734
Partner-CN8-month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Partner-time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CN8-time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust s.e. clustered at partner-CN8 level. * p<0.10, ** p<0.05, *** p<0.01. The table reports the first stages using the EU PRF share to instrument the UK PRF share 2013-19. In columns 1-4 the dependent variable is the average applied tariff computed as $\ln \tau_{hit} = s_{hi}^{PRF} \ln \tau_{hit}^{PRF} + s_{hi}^{MFN} \ln \tau_{ht}^{MFN}$. In columns 5-8 the dependent variable is the MFN risk computed as $s_{hi}^{PRF} \times \omega_{hi}$, where $\omega_{hi} = 1 - (\tau_{hi}^{PRF}/\tau_{h}^{MFN})^{\sigma}$ with $\sigma = 4$. In column 9 the dependent variable is the interaction of the Continuity Agreement dummy with the MFN risk.

Table 23: Reduced IV PRF share 2013-19 and tariff margin, first stage

	Tariff				MFN risk				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	lag=0	lag=1	lag=2	lag=3	2016	2017	2018	2019	Cont. Ag.
Tariff IV, lag=0	0.920***	-0.030***	-0.009***	-0.009***	0.234***	0.271***	-0.034***	0.187***	0.123***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.011)	(0.011)	(0.011)	(0.011)	(0.010)
Tariff IV, lag=1	-0.021***	0.931***	-0.031***	-0.012***	0.188***	0.221***	0.269***	-0.039***	-0.021**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.010)	(0.010)	(0.010)	(0.010)	(0.009)
Tariff IV, lag=2	-0.002***	-0.021***	0.931***	-0.007***	-0.299***	0.067***	0.109***	0.218***	0.156***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.009)	(0.009)	(0.009)	(0.009)	(0.008)
Tariff IV, lag=3	0.002***	-0.001*	-0.007***	0.909***	0.001	-0.181***	0.064***	0.152***	0.044***
	(0.000)	(0.000)	(0.001)	(0.001)	(0.007)	(0.007)	(0.007)	(0.007)	(0.006)
MFN risk IV, 2016	-0.001***	0.000	0.002***	0.006***	0.715***	-0.010***	-0.006**	-0.010***	-0.007***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)
MFN risk IV, 2017	-0.001***	-0.000	0.001***	0.006***	-0.012***	0.736***	-0.014***	-0.015***	-0.007***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
MFN risk IV, 2018	-0.001***	-0.000**	0.001***	0.007***	-0.008***	-0.015***	0.738***	-0.019***	-0.012***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
MFN risk IV, 2019	-0.001***	-0.000	0.000**	0.006***	-0.014***	-0.016***	-0.020***	0.755***	-0.062***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)
Cont. Ag. IV	0.000**	0.000**	0.000	-0.000	0.009***	0.014***	0.013***	-0.063***	0.873***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Observations	554,734	554,734	554,734	554,734	554,734	554,734	554,734	554,734	554,734
Partner-CN8-month FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Partner-time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CN8-time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust s.e. clustered at partner-CN8 level. * p<0.10, ** p<0.05, *** p<0.01. The table reports the first stages using the EU PRF share to instrument the UK PRF share 2013-15 and the median of the tail risk computed with the MFN tariffs of the Australia, Canada, Japan and the US to instrument the UK tail risk. In columns 1-4 the dependent variable is the average applied tariff computed as $\ln \tau_{hit} = s_{hi}^{PRF} \ln \tau_{hit}^{PRF} + s_{hi}^{MFN} \ln \tau_{ht}^{MFN}$. In columns 5-8 the dependent variable is the MFN risk computed as $s_{hi}^{PRF} \times \omega_{hi}$, where $\omega_{hi} = 1 - (\tau_{hi}^{PRF}/\tau_{h}^{MFN})^{\sigma}$ with $\sigma = 4$. In column 9 the dependent variable is the interaction of the Continuity Agreement dummy with the MFN risk.