Could tariffs be pro-cyclical?

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February 14, 2015

Abstract

Conventional wisdom says that tariffs are counter-cyclical. This paper analyzes the relationship between business cycles and applied tariffs using a disaggregated product-level panel dataset covering 72 countries between 2000 and 2011. Strikingly, and counter to conventional wisdom, we find that tariffs are pro-cyclical. This pro-cyclicality is driven by the pre-Great Recession tariff-setting behavior of developing countries on products not subject to temporary trade barriers and does not depend on the importer's perception of the global business cycle or whether the tariff is bound. Results are robust to controlling for variables emphasized in recent literature as important determinants of tariff setting.

JEL: F13, F14, E32

Keywords: Applied tariff, bound tariffs, binding overhang, tariff water, business cycle

1 Introduction

Conventional wisdom reflects the introduction of Bagwell and Staiger (2003, p.1): "Empirical studies have repeatedly documented the countercyclical nature of trade barriers." Indeed, this is a long-held view in both the economics and political science literature; see, for example, Takacs (1981, p.687), Gallarotti (1985, p.157), Cassing et al. (1986, p.843), Rodrik (1995, p.687), Costinot (2009, p.1011) and Bown and Crowley (2013a, p.50). While recent empirical evidence by Knetter and Prusa (2003), Bown and Crowley (2013a) and Bown and Crowley

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(2014) has supported the idea that temporary trade barriers are counter-cyclical, recent empirical evidence by Gawande et al. (2011), Kee et al. (2013) and Rose (2013) suggests instead that applied tariffs are acyclical.

As argued by Bagwell and Staiger (2003, p.1), the theoretical basis for the conventional wisdom on the counter-cyclicality of protection is less than clear. The standard explanation is that recessions cause import-competing firms to lobby harder for protection, and policy makers respond by raising tariffs. However, this account ignores the role of lobbying by non-import-competing sectors that prefer lower tariffs, such as export sectors or sectors that rely on imported intermediate inputs, and thus provides no justification for the preference of policy makers for import-competing sectors over these other sectors. Indeed, because of this tension, Bagwell and Staiger (2003) move away from domestic political economy considerations as an explanation of applied tariff counter-cyclicality and instead pursue a theory based on terms of trade externalities.

Our paper contributes to the literature questioning the counter-cyclicality of applied tariffs. Our results are based on a product-level dataset covering more than 5000 products and 72 developing and developed countries over the years 2000 to 2011. As has been emphasized recently (e.g. Handley and Limão (2012), Beshkar et al. (2014), Handley (2014) and Lake and Linask (2014)), a country's applied tariff choice for any given product cannot exceed the "tariff binding" that the country committed to in the 1994 Uruguay Round of tariff negotiations. This institutional constraint restricts the flexibility that countries have to alter their applied tariffs and, as often occurs in many developed countries, completely eliminates any flexibility when the tariff binding is zero. The difference between the tariff binding and the applied tariff is known as "binding overhang" (or "tariff water"), and our empirical analysis focuses on using binding overhang as the dependent variable so that our estimation procedure can explicitly take into account the constraint that the applied tariff cannot exceed the tariff binding.

Indeed, our use of disaggregated data is in part motivated by this feature of WTO tariff schedules. In particular, aggregation mixes products with different degrees of flexibility including some products with zero flexibility. Disaggregation allows us to isolate and exclude those products with zero bound tariffs, i.e. zero flexibility in setting applied tariffs, since these products by definition will have no cyclicality in applied tariffs. Moreover, our approach recognizes that lobbying typically takes place at a disaggregated level and that aggregation, particularly at the national level, can conceal critical variation in applied tariffs. The use of disaggregated tariff data for a broad range of countries over a 10-year period is thus a distinctive feature of our paper.

The main result, which focuses on the pre-Great Recession period of 2000-2009, is that applied tariffs actually appear pro-cyclical; this is completely counter to the conventional wisdom that applied tariffs should be counter-cyclical. It is also in contrast to recent empirical evidence that temporary trade barriers, an alternative form of protectionism that we do not analyze in this paper, are counter-cyclical (Bown and Crowley (2013a), Bown and Crowley (2014)). Indeed, our results suggest that fluctuations related to the business cycle represent about 15% of the average applied tariff change and thus indicate a non-trivial role for these fluctuations in explaining the temporal pattern of applied tariffs.

The finding that applied tariffs are actually pro-cyclical is robust to the inclusion of numerous control variables that have recently been emphasized in the empirical and theoretical literature as important determinants of binding overhang and applied tariffs. These include market power at the country-product level, the product-level share of imports sourced from PTA partners, time varying import surges at the country-product level, and the volatility of import surges at the country-product level. Our results are also robust to various measures of the business cycle and extending our sample through the Great Recession years of 2010-11.

We also investigate how the pro-cyclicality of applied tariffs differs by various characteristics. Importantly, we find that the pro-cyclicality in the overall sample is driven by developing countries, and that applied tariffs are acyclical for the subsample of developed countries. Further, for developing countries, we find that (i) applied tariffs are acyclical for country-products that are subject to temporary trade barriers and also for the Great Recession years of 2010-11 when we extend the baseline sample through these years, (ii) there is some evidence that applied tariffs could be acyclical for intermediate goods and (iii) the pro-cyclicality of applied tariffs does not depend on the perception of the (import-weighted) global business cycle held by importers or whether products do or do not have tariff bindings.

Given the persistence of the conventional wisdom about the counter-cyclicality of tariff protection, a number of studies have proposed theoretical mechanisms underlying this relationship. Explanations include the maintenance of budget balances (Hansen (1990)); the relationship between business cycles, firm entry incentives and pro-tariff lobbying of incumbent firms (McKeown (1983) and Gallarotti (1985)); the notion that import-competing sector employment is more responsive to tariffs when unemployment is higher (Costinot (2009)); and the cost of deviating from a reciprocal trade agreement in the context of persistent business cycles and pro-cyclical trade volumes (Bagwell and Staiger (2003)).

However, to our knowledge, Lake and Linask (2014) provide the only theoretical explanation for pro-cyclical applied tariffs. They view the government as captured either by interests of the export or import-competing sector. During recessions (booms), the opportunity cost of using resources for lobbying rather than for productive purposes is low (high). In turn, the stronger (weaker) threat of lobbying during recessions (booms) leads importers (exporters) to set lower (higher) tariffs in recessions compared to booms as a means to pre-emptively avoid lobbying by the opposing group and maintain capture of the government. Hence, applied tariffs should be pro-cyclical (and, given an exogenous tariff binding, binding overhang should be counter-cyclical) if importers have captured the government and are dictating applied tariffs.

Empirically, a number of studies have analyzed the cyclicality of protectionism using pre-World War II data (McKeown (1983), Gallarotti (1985) and Hansen (1990)) and data that spans pre- and post-World War II (Magee and Young (1987), Bohara and Kaempfer (1991a) and Bohara and Kaempfer (1991b)). These studies generally focus on establishing counter-cyclical applied tariffs in the US, Germany and the UK. Those focusing on pre-World War II data consistently found counter-cyclicality while those spanning pre- and post-World War II had less consistent findings. Indeed, although they do not emphasize this, the results of Bohara and Kaempfer (1991b) indicate a pro-cyclical relationship between real GNP and applied tariffs.[1]

The two closest related papers to ours are Gawande et al. (2011) and Rose (2013), both of which find applied tariff protection to be acyclical. Gawande et al. (2011) focus on 7 developing countries and analyze the factors influencing how product-level (i.e. 6-digit HS6) applied tariffs differed in 2009 from the preceding three-year period of 2006-2008. Despite some heterogeneity across countries, their main conclusion is that any effects of additional lobbying by domestic import-competing firms was offset by domestic users of imported intermediate inputs, an ever growing group given the rise of vertical specialization and global fragmentation. Our analysis bears resemblance to Gawande et al. (2011) because we use disaggregated product-level data but differs because we do not restrict our sample to focus on the Great Recession or on a small subset of developing countries.

Rose (2013) analyzes more than 180 countries over a 40 year period through 2010. He looks at how a variety of business cycle measures relate to various measures of protectionism including country-level average applied tariffs, multiple measures of temporary trade barriers, and disputes initiated through the WTO. His main finding is straightforward (p.572): "during the post-World War II era, protectionism has not been counter-cyclic." Our analysis bears resemblance to Rose because of our interest in a long time span (although not as long as Rose) and a broad range of countries but differs because of our use of disaggregated product-level data.[2] Indeed, to our knowledge, ours is the first paper to focus on the

[1] Bohara and Kaempfer (1991b) use annual US data from 1890-1970 to estimate a three equation VAR model with real GNP, unemployment and the average applied tariff. The point of their paper is that macroeconomic variables Granger cause tariffs but not vice-versa.

[2] Kee et al. (2013) compute the "overall trade restrictiveness index" (OTRI) for over 100 countries in 2008 and 2009 which computes a country level "average tariff" by aggregating bilateral applied tariffs and bilateral

cyclicality of applied tariffs (or binding overhang) over the post-WTO period using a broad range of countries and disaggregated tariff data. To this end, the following quote by Hansen (1990, p.572) is particularly salient: "Among quantitative studies, most model the rates of duty in the cross-section, across industries, usually in recent periods ... Only a handful of quantitative studies examine policy variations over time."

Although we focus on product-level applied tariffs as a measure of protectionism, our analysis is also related to recent work investigating the cyclicality of temporary trade barriers (TTBs) as an alternative form of protectionism. Indeed, in contrast to both this paper and the aforementioned recent studies which emphasize that applied tariffs are not counter-cyclical, Knetter and Prusa (2003), Bown and Crowley (2013a) and Bown and Crowley (2014) report that temporary trade barriers are counter-cyclical.[3]

Finally, our paper is related to recent papers investigating the theoretical and empirical determinants of binding overhang itself and applied tariffs in the presence of binding overhang. Beshkar et al. (2014) develop a theoretical model where countries have private information about their political economy motives for protection. They show that, quite intuitively, an optimal trade agreement assigns lower binding overhang to countries who have the greatest market power and hence the greatest ability to manipulate their terms of trade. Moreover, they present supporting empirical evidence using product-level data for a cross-section of over 100 countries in 2007. Unlike Beshkar et al. (2014), Nicita et al. (2013) focus on how the relationship between market power and applied tariffs depends on the level of binding overhang. Empirically, they find a positive (negative) relationship when binding overhang is high (low). This suggests that countries may set applied tariffs in a non-cooperative (cooperative) way when binding overhang is high (low). Further, Nicita et al. (2013) provide empirical evidence suggesting that the fear of retaliation may underlie this dichotomy.

The rest of the paper proceeds as follows. Section 2 introduces our main empirical specifications. Section 3 describes our data and illustrates the variation in the data that drives our empirical results. Section 4 presents and discusses our baseline empirical results and Section 5 investigates numerous robustness specifications. The final section concludes.

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anti-dumping duties from the HS6 level using bilateral trade flows and bilateral import demand elasticities. They find no widespread increase in the OTRI across countries, although a small minority of countries did experience relatively minor increases because of spikes in applied tariffs and anti-dumping duties. Further, they conclude that any increase can explain only a very small part of the 2009 global trade collapse.

[3]Bown and Crowley (2013a) use quarterly data for 5 industrialized countries during the pre great recession period of 1998-2010 and focus on the effects of unemployment, real bilateral exchange rate appreciation and GDP growth declines of bilateral trading partners. Bown and Crowley (2014) undertake a similar analysis using annual, rather than quarterly, data for 13 developing countries between 1995 and 2010. Knetter and Prusa (2003) use more aggregated data and focus on the effects of real exchange rate appreciation for 4 industrialized countries between 1980 and 1998.

2 Empirical Models

Attempting to estimate the cyclicality of binding overhang creates a number of issues regarding the estimation technique. To address these concerns, we use various estimation techniques with all specifications using applied tariffs and tariff bindings at the product (i.e. 6-digit HS6) level.

Our simplest estimation technique is fixed effects OLS. Here, we estimate the following equation:

$$v_{i,j,t} = \theta BC_{i,t-1} + \mathbf{x}_{i,j,t}\beta + \gamma_t + \gamma_{i,HS4} + \varepsilon_{i,j,t}. \tag{1}$$

$v_{i,j,t}$ denotes binding overhang for country i in product j and year t. Letting $\bar{\tau}_{i,j,t}$ and $\tau_{i,j,t}$ denote the tariff binding and MFN applied tariff, respectively, imposed by country i on product j in year t, then $v_{i,j,t} = \bar{\tau}_{i,j,t} - \tau_{i,j,t}$. $BC_{i,t-1}$ is a lagged measure of the business cycle in country i and so θ is our primary parameter of interest. Given recent empirical and theoretical work in the literature, we also include a vector of control variables $\mathbf{x}_{i,j,t}$. In our baseline analysis, $\mathbf{x}_{i,j,t} = [MP_{i,j}, PTA\_IM_{i,j,t}, y_{i,t}]$ where $MP_{i,j}$ is a measure of market power for the importing country i in the market for product j, $PTA\_IM_{i,j,t}$ is a measure of the share of country i's imports of product j in year t sourced from preferential trade agreement (PTA) partners, and $y_{i,t}$ is contemporaneous log real GDP per capita. In Section 5, we expand the vector of control variables.

Various recent papers have emphasized the relationship between market power and tariff setting (see Bagwell and Staiger (2011), Ludema and Mayda (2013), Nicita et al. (2013) and Beshkar et al. (2014)). We follow Nicita et al. (2013) and Beshkar et al. (2014) and measure the market power for importer i in product j, denoted $MP_{i,j}$, as $\ln(1/e_{i,j})$ where $e_{i,j}$ is the export supply elasticity of the rest of the world faced by importer i in the market for product j. Like Nicita et al. (2013) and Beshkar et al. (2014), we treat market power as potentially endogenous and deal with this possibility using the instrumental variables approach of Nicita et al. (2013).

In addition to the role of market power, Ludema and Mayda (2013) also emphasize the importance of controlling for the share of imports sourced from PTA partners. The impact of this variable could arise, for example, because of political economy mechanisms emerging from the interest of PTA partners to maintain the preferential market access they receive relative to non-PTA partners in the form of the applied tariff (also see, e.g., Limão (2007)). Given that a higher share of PTA imports essentially undermine the protection provided by an applied tariff, this share could also affect domestic political economy mechanisms. Thus, we include $PTA\_IM_{i,j,t}$ which is a measure of the share of product j imports into importing country i in year t that are sourced from importer i's PTA partners.

Finally, since country-level tariff setting decisions could vary by income, we also control for contemporaneous log real per capita GDP for country i, $y_{i,t}$.

In addition to these control variables, fixed effects are embedded within a composite error term $\tilde{\varepsilon}_{i,j,t}$ consisting of an idiosyncratic component $\varepsilon_{i,j,t}$ as well as year fixed effects γ_t and importer-sector fixed effects $\gamma_{i,HS4}$. Year fixed effects γ_t help control for any time-specific factors that affect all countries simultaneously and could be correlated with domestic business cycles. Importer-sector fixed effects $\gamma_{i,HS4}$ define a sector as the group of HS6 products within a 4-digit HS4 category. These control for any time-invariant characteristics of sectors within countries. The use of importer-sector fixed effects implies that our results are driven by variation within these importer-sector clusters and not cross-sector variation within a country or cross-country variation within (or across) sectors.

Notice that our key variable of interest is measured at a more aggregated level than our dependent variable. That is, the country-year measure of the business cycle $BC_{i,t}$ is more aggregated than the country-product-year measure of overhang $v_{i,j,t}$. As recognized recently in the trade literature by, for example, Ludema and Mayda (2013, p.1866), it is important that we cluster the standard errors at the country-year level to match the aggregation level of our key regressor. Further, despite our use of country-HS4 fixed effects, there could be correlation between error terms at the country-HS4 level (either serial correlation for a given HS6 product or temporal correlation between different HS6 products within a HS4 sector). We therefore use the two-way clustering approach developed by Cameron et al. (2011) and cluster our standard errors at both the country-year level and the country-HS4 level.

While the simplicity of OLS is certainly appealing, OLS suffers an important drawback for analyzing binding overhang: by construction, binding overhang must be non-negative because WTO rules prohibit the applied tariff exceeding the tariff binding. Previous work (e.g. Beshkar et al. (2014)) has addressed this issue by using a Tobit specification. However, as is well known, the Tobit model yields inconsistent estimators in the presence of fixed effects (i.e. the incidental parameters problem) and also when the idiosyncratic error term is heteroskedastic (see for example Greene (2004) and Cameron and Trivedi (2009, p.537)).[4] Partly because of its ability to deal with these issues, PPML (Poisson psuedo-maximum likelihood) has become a popular method for dealing with the problem of zeros in the gravity literature (see Silva and Tenreyro (2006)).[5] Thus, we also implement PPML estimation in

[4]Not only is the assumption of homoskedasticity crucial for consistent estimation of the parameters in the Tobit model, but so is normality (Cameron and Trivedi (2009, p.537)).

[5]Greene (2004, p.126) is one example emphasizing that the Poisson model is an exception to the rule of thumb that maximum likelihood based models suffer from the incidental parameters problem. However, theory showing that the Poisson model with multiple fixed effects does not suffer from the incidental parameters problem is still evolving. Fernández-Val and Weidner (2013) establishes the case with two fixed effects.

order to deal with the non-negativity of overhang.

Although Poisson estimation is often used to model count or integer data, the gravity literature has recently emphasized that estimation by PPML does not depend on the data being of an integer nature but only that the conditional mean of the dependent variable given the regressors is an exponential function (see, e.g., Silva and Tenreyro (2006)). In our context, this equates to

$$v_{i,j,t} = \exp\left(\theta BC_{i,t-1} + \mathbf{x}_{i,j,t}\beta + \gamma_t + \gamma_{i,HS4}\right) + \varepsilon_{i,j,t} \tag{2}$$

and the assumption that $\mathrm{E}\left(\varepsilon_{i,j,t}|BC_{i,t-1}, \mathbf{x}_{i,j,t}, \gamma_t, \gamma_{i,HS4}\right) = 0$. This implies that $\mathrm{E}(v_{i,j,t}|BC_{i,t-1}, \mathbf{x}_{i,j,t}, \gamma_t, \gamma_{i,HS4}) = \exp\left(\theta BC_{i,t-1} + \mathbf{x}_{i,j,t}\beta + \gamma_t + \gamma_{i,HS4}\right)$. Unfortunately, two-way clustering procedures do not yet exist for PPML. Thus, rather than cluster standard errors at both the country-year and country-HS4 level as we do when estimating OLS specifications, we take the more conservative approach and cluster standard errors at the country level when estimating PPML specifications. This is more conservative because it allows arbitrary correlation of errors between any two HS6 products that a country imports rather than only allowing such correlation between two products within a given HS4 sector. Thus, the threshold for obtaining statistical significance in the PPML specifications that follow is quite demanding.

3 Data

3.1 Overview

Our baseline dataset has $1,811,008$ country-product year observations for 72 countries countries at the disaggregated product (i.e. 6-digit HS6) level between 2000 and 2009 (see Table A1 in the Appendix). Table A2 in the Appendix summarizes our data and the sources for these data.

All bound tariff data are from the WTO's Integrated Data Base tariff database via WITS (World Integrated Trade Solution). Most applied tariffs are also from the WTO database but for some country-year combinations where the WTO data were missing we obtain these from the UNCTAD TRAINS database using WITS. Given our focus on changes in tariffs over time for a given country, we restrict our sample to countries for which we have tariff data in eight of the ten years in our primary years of interest, 2000-2009.

We set 2000-2009 as our baseline years for three reasons. First, we exclude 2010 and 2011 from the baseline analysis in order to avoid any structural changes in policies or policy-making that may have been induced by the Great Recession. We do investigate the impact of these years in Section 5. Second, the Uruguay Round that was concluded in 1994 resulted in significantly different tariff bindings relative to the pre-Uruguay Round period; thus we limit attention to the post–1994 WTO years. Finally, in order to understand the relationship between business cycles and tariff protection, it is critical to avoid reaching conclusions about the cyclicality of overhang and applied tariffs based on the institutional necessity of reducing applied tariffs to meet these new tariff binding obligations. Because the agreement allowed countries to phase in their applied tariff reductions over time, we therefore exclude the years during which such phase-ins were permitted. Given that the phase-in period for industrial products was 5 years whereas developed countries were given 6 years for agricultural products and developing countries were given 10 years for agricultural products (Hoda (2001, p.66)), we therefore exclude the years 1995-1999 in their entirety and agricultural products for the additional years.

In addition to the phase-in of applied tariffs stemming from Uruguay Round bound tariff obligations, we account for two other institutional features that relate to the timing of applied tariff reductions. Countries joining the WTO after 1995 submitted detailed product-by-product schedules for tariff reductions. We obtain the tariff binding schedules of all new WTO members and exclude any product-year observations during the phase-in period. Finally, many countries joined the Information Technology Act (ITA) and have thereby committed to zero tariff bindings on hundreds of information technology products. Again, we collect each country's ITA schedule and exclude any country-product observations during the respective phase-in period.[6]

Our main control variable, the business cycle $BC_{i,t-1}$, as well as the log per capita real GDP control variable require collection of GDP data. For most countries, we obtain this GDP data from the World Bank's World Development Indicators that stretches back to 1960 for many countries.[7,8] Like Rose (2013), our baseline results measure the business cycle by estimating the cyclical component of log real GDP using the Hodrick-Prescott (HP) filter (Hodrick and Prescott (1997)). The HP filter has been used to measure the business cycle in a variety of fields ranging from trade (e.g. Rose (2013)) to labor (Chang and Kim (2007)) and environmental economics (Heutel (2012) and Doda (2014)). Moreover, as stated by Ravn and Uhlig (2002, p.371), "... it has withstood the test of time and the fire of discussion remarkably well" and "... although elegant new bandpass filters are being developed (Baxter and King (1999), Christiano and Fitzgerald (2003)), it is likely that the HP filter will remain one of the standard methods for detrending." In Section 5, we analyze robustness of our

[6] ITA schedules were obtained from http://www.wto.org/english/tratop_e/inftec_e/itscheds_e.htm.

[7] To construct EU real GDP in any given year, we aggregate real GDP for the 15 individual EU countries as of 1999. That is, for data purposes, we treat EU membership as time-invariant and dictated by 1999 membership.

[8] WDI data for Qatar starts in 1994 so we use UN data prior to 1994.

baseline results by using the Baxter-King and Christiano-Fitzgerald filters to compute the business cycle variable.

Until recently, obtaining disaggregated measures of market power for a large cross-section of countries was not possible. However, Nicita et al. (2013) have estimated export supply elasticities from the view of the importer for over 100 countries and thousands of products at the HS6 level. They use these to construct the market power variable $MP_{i,j} = \ln\left(\frac{1}{e_{i,j}}\right)$ described in the previous section. Moreover, they also compute import demand elasticities as well as export supply elasticities from the view of the exporter and use world averages of these to instrument for market power. We follow the same approach as Nicita et al. (2013) given Peri da Silva kindly provided us with these elasticity data.

In order to compute $PTA\_IM_{i,j,t}$, the share of country i's imports in product j in year t that are sourced from PTA partners, we need to know country i's PTA partners in each year and we also need trade data that splits country i's product-level imports among source countries. For the former, we use the NSF-Kellogg Institute Data Base on Economic Integration Agreements, originally created by Scott Baier and Jeffrey Bergstrand, to extract the countries who have an FTA or a CU in each year of our sample.[9] While Ludema and Mayda (2013) do not treat their PTA import share variable as endogenous, we are concerned that temporal changes in applied tariffs could affect the share of imports coming from PTA partners given that an applied tariff represents a preferential margin that PTA partners enjoy over non-PTA members. To minimize any such endogeneity problem, we use time-invariant trade shares prior to the importing country appearing in our sample when computing $PTA\_IM_{i,j,t}$. Specifically, let $PTA_{i,k,t}$ be an indicator variable (i.e. taking on a value of 0 or 1) that indicates whether countries i and k have an FTA or a CU in year t and let $IM_{i,j,k}$ be country i's imports of product j from country k in some year prior to country i appearing in our sample. Then,

$$PTA\_IM_{i,j,t} = \sum_{k \neq i} \frac{IM_{i,j,k}}{\sum_k IM_{i,j,k}} PTA_{i,k,t}. \tag{3}$$

With some exceptions, we use 1999 trade data for the trade flows $IM_{i,j,k}$ and we obtain these trade flows from COMTRADE using the WITS database.[10]

In addition to the variables described above, we augment the dataset with additional control variables for the robustness analysis in Section 5. First, we add variables related to

[9] The database itself only goes through 2005, but it also provides a list of agreements for 2006-2012 that have not yet been entered into the database itself. We add these agreements into the database.

[10] Lack of trade data availability causes us to use trade data from years other than 1999 for some countries. We use 2000 trade shares for Qatar and Bahrain which still ameliorates any endogeneity concerns because there is no tariff data for these countries in 2000.

import surges as in Bown and Crowley (2013b), whose empirical implementation of import surges is motivated by the theoretical work of Bagwell and Staiger (1990). Specifically, we compute country i's lagged change in imports of product j in a given year as well as its standard deviation and we also compute country i's lagged change in the world share of product j imports in a given year as well as its standard deviation. Letting $IM_{i,j,t}$ denote country i's imports of product j in year t, these variables are $\Delta IM_{i,j,t-1} \equiv IM_{i,j,t-1} - IM_{i,j,t-2}$, $sd\Delta IM_{i,j,t-1}$, $\Delta IM^{share}_{i,j,t-1} \equiv \frac{IM_{i,j,t-1}}{\sum_i IM_{i,j,t-1}} - \frac{IM_{i,j,t-2}}{\sum_i IM_{i,j,t-2}}$ and $sd\Delta IM^{share}_{i,j,t-1}$. Second, we control for whether country i imposes a temporary trade barrier (TTB) on product j in year t using data on TTBs from the World Bank's Temporary Trade Barriers Database (Bown (2010)). Third, we add whether product j is an intermediate good or not based on Rauch (1999).[11] Fourth, we add a variable intended to proxy for the global business cycle from the perspective of the importer. To calculate this proxy, let $IM_{i,k}$ be country i's imports from country k in the year underlying $IM_{i,j,k}$ in (3). Then, we define the trade weighted global business cycle from the perspective of the importer country i as

$$GBC_{i,t-1} = \sum_{k \neq i} \frac{IM_{i,k}}{\sum_k IM_{i,k}} BC_{k,t-1}.$$

As described above, we exclude any observations where a country is still in a phase-in period for a particular product and is thus not obliged to abide by its tariff binding. We also exclude a number of other observations. First, we eliminate observations for a country prior to it joining the WTO because then it was not constrained by any tariff bindings (see Table A1 for details on new members). We also exclude a number of relatively rare occurrences in the data: i) any country-product observations where the binding is not constant over the sample period, ii) observations with negative overhang and iii) observations where the applied tariff moves below the tariff binding following observations where the applied tariff moved above the binding. We exclude these because we are not interested in explaining the rare occurrences related to changes in tariff bindings, countries violating WTO rules by ignoring their tariff bindings, or countries reducing applied tariffs to rectify such violations.[12] Finally, we exclude outlier observations related to changes in applied tariffs: specifically, we exclude observations if the magnitude of the applied tariff change lies in the top 1% of applied tariff increases or the top 1% of applied tariff decreases. These exclusions yield the total of $1,811,008$ observations referred to at the beginning of this section. Table A3 presents summary statistics for this overall sample and breaks the sample down by level of

[11] We used a concordance to map the raw data (see Table A2 in the Appendix) into HS6 products.

[12] Indeed, use of PPML requires the dependent variable take non-negative values.

development.[13]

A few points stand out from the summary statistics. Regarding the tariff variables, there is a significant amount of overhang which gives countries significant leeway in changing their applied tariffs up and down over time. For the overall sample, the mean tariff binding is 23% while the mean applied tariff is only 7.9% which leads to a mean overhang of 15.35%. While developing countries have both a larger mean tariff binding and mean applied tariff than developed countries (29.64% vs. 10.3% and 10.14% vs. 3.28% respectively), the larger tariff bindings dominate the larger applied tariffs and lead to higher mean overhang in developing than developed countries (19.92% vs. 6.7%). Along similar themes, developing countries are more likely to have products that have no tariff binding (20.5% of observations vs. 13.4% of observations) and much less likely to have zero tariff bindings (2.2% of observations vs. 26.6% of observations).

There are also some differences between developing and developed countries with regard to the covariates. On average, countries are 0.16% above trend GDP over our sample period with a standard deviation of 1.9% points. The business cycle is, on average, weaker in developing countries (0.1% above trend vs. 0.27% above trend) although, perhaps surprisingly, the variation in the business cycle is similar between developing and developed countries (2% points vs. 1.8% points). When computing a trade weighted measure of the global business cycle from the perspective of importers, there is virtually no difference between developed and developing countries with a mean in the overall sample of 0.32% above trend and a standard deviation of 1.1% points. The higher mean and lower standard deviation of this trade weighted global business cycle variable relative to the individual country business cycle variable indicates that countries tend to trade with countries that on average have stronger and more stable business cycles. Finally, developing countries tend to have lower market power than developed countries, to impose temporary trade barriers somewhat less frequently (1% of observations vs. 1.2% of observations), and to have smaller and more stable import growth.

3.2 Preliminary evidence of pro-cyclical applied tariffs

Before presenting the results of the main empirical analysis, we first illustrate the variation in the data that drives our regression results.

In order to analyze the relationship between applied tariffs and the business cycle, we first need to ensure that applied tariffs indeed vary over time and that they both increase

[13] We use the World Bank's historical classification (see notes to Table A1) to classify a country as developed (high-income per the World Bank) or developing (not high-income per the World Bank).

and decrease.[14] Panel A of Table 1 summarizes the frequency of tariff changes in our sample. In 11.68% of observations, the applied tariff changed relative to the prior year, and this is much higher in developing than developed countries (15.03% vs. 5.34%). While applied tariff decreases are far more common than applied tariff increases, Panel B shows that applied tariff increases are non-trivial events. When applied tariffs change, Panel B shows that 18.92% of such observations are applied tariff increases with this dropping slightly to 18.16% for developing countries but rising to 22.66% for developed countries. While Panel A shows that the average direction of an applied tariff change is negative, which is unsurprising given the relative frequency of applied tariff decreases, Panel B shows that the average size of applied tariff increases and decreases is around 3.5-4% points both for the overall sample and for the subsample of developing countries.

Figure 1 illustrates the pattern of applied tariff changes over time. While the baseline analysis extends only through 2009, we extend these graphs through 2011 to incorporate the Great Recession years since we include these years in the extended analysis in Section 5. Panel A shows a noticeable downward trend in the frequency of applied tariff decreases over time with this number falling from about 16% of all observations in the early 2000s to the 4-6% range in the 2006-2011 period. While applied tariff increases accounted for 4-4.5% of observations in the early 2000s, they have remained a steady share of 1-1.5% of observations since 2004. Thus, throughout the sample period, applied tariff increases represent a non-negligible proportion of applied tariff changes.[15]

Panel B of Figure 1 provides one aggregate view of the relationship between applied tariffs and the business cycle. Here we plot the global share of applied tariff changes that are applied tariff increases against a measure of the global business cycle that merely averages $BC_{i,t-1}$ across all observations in a given year of our sample. Evidence at this level of aggregation does not suggest that the global share of applied tariff changes accounted for by applied tariff increases are systematically related to the average business cycle across countries.[16] The dramatic drop in the average business cycle across countries in 2010 and 2011 clearly indicates that the observations for 2010 and 2011 in our sample correspond to the Great

[14] Using a sample of 10 Latin American countries between 1990 and 2001, Estevadeordal et al. (2008) is one of the few papers that document product level applied tariffs both rise and fall over time.

[15] With roughly 5000 HS6 products, this amounts to an average of 75 products for which the applied tariff increases per country-year. Further, given the emphasis placed on temporary trade barriers in the recent literature, it is worthwhile noting that applied tariff increases are more common that the imposition of new TTBs even amongst the most prolific users of TTBs. The eight most-prolific TTB users between 2000 and 2009 imposed 1694 new TTBs but, in our sample, they raised applied tariffs on 7694 occasions. Indeed, of these eight countries, only the EU had more new TTBs than applied tariff increases.

[16] This is consistent with the results in Rose (2013) who analyzes cyclicality of tariffs aggregated at the national level.

Recession.[17]

Since aggregation conceals much variation, the empirical analysis in Section 4 focuses on the cyclicality of overhang and applied tariffs at the product level. If applied tariffs exhibit cyclicality, there should be products where countries move the applied tariff up and down over the business cycle (in contrast to, for example, permanently raising applied tariffs on some products during booms and permanently lowering applied tariffs on other products during recessions). Panel C of Table 1 illustrates the type of tariff changes that occur over the duration of our sample within country-product clusters. Overall, 37.17% of country-products experience no change in the applied tariff over our sample period; this rate is much smaller (larger) for developing (developed) countries. A further 36.93% of country-products only experience a decrease in the applied tariff over the sample period, which is significantly larger than the share of country-products that only experience an applied tariff increase over the sample period. Perhaps surprisingly, 22.54% of country-products experience both an applied tariff increase and an applied tariff decrease over our sample period, and this share is much greater in developing countries compared to developed countries (30.37% vs. 7.9%). Thus, there is a significant number of products where countries move the applied tariff up and down over the sample period.

Figure 2 illustrates how the variation in applied tariffs for this last group of country-products, i.e. those that experience both an applied tariff increase and decrease over the sample period, provides preliminary evidence that applied tariffs could be pro-cyclical. Panel A of Figure 2 plots the difference between the applied tariff for a country-product-year ($\tau_{i,j,t}$) and the mean applied tariff for this country-product ($\tilde{\tau}_{i,j} \equiv \frac{1}{10}\sum_{t=2000}^{2009}\tau_{i,j,t}$) against the difference between the contemporaneous business cycle measure for the country ($BC_{i,t-1}$) and the mean business cycle for the country ($\widetilde{BC}_i \equiv \frac{1}{10}\sum_{t=2000}^{2009} BC_{i,t-1}$); the figure also shows the OLS regression line of $\tau_{i,j,t} - \tilde{\tau}_{i,j}$ on $BC_{i,t-1} - \widetilde{BC}_i$. The observations are restricted to i) those country-product clusters where the applied tariff moves both up and down over the sample period and ii) the years within those country-product clusters where the applied tariff changed from the previous year. For products with varying applied tariffs, the figure thus shows how the deviation of an applied tariff $\tau_{i,j,t}$ from its sample average relates to the deviation of the country's business cycle $BC_{i,t-1}$ from its sample average. The positive slope of the OLS regression line provides some preliminary evidence suggesting that applied tariffs could indeed be pro-cyclical.

The magnitude of pro-cyclicality suggested by the positive slope of the OLS regression line in Panel A of Figure 2 is non-trivial. On average, the difference between a country's

[17] Since our business cycle measure is $BC_{i,t-1}$, the 2010 and 2011 tariff observations relate to 2009 and 2010 GDP data.

maximum and minimum value of $BC_{i,t-1}$, which is a proxy for the difference between the peak of the boom and the trough of the recession, is about .053 with a standard deviation of .033. The slope of 29.25 then implies a difference of about 1.55% points between the applied tariff at the peak of the boom and the trough of the recession. Given that the average magnitude of an applied tariff change is about 3.5-4% points, this difference of 1.55% points induced by the business cycle represents about 40-45% of the average applied tariff change.

Finally, Panel B of Figure 2 performs the same analysis as Panel A but expands the observations to include country-product clusters that only experience applied tariff increases or only experience applied tariff decreases.[18] Including these additional observations leaves the story from Panel A intact. Together, these two panels of Figure 2 illustrate the variation in data that drive the results in Section 4.

4 Empirical Results

4.1 The counter-cyclicality of overhang

Table 2 presents the OLS results from estimation of equation (1). Column (1) excludes fixed effects and only includes the business cycle covariate ($BC_{i,t-1}$). Columns (2) and (3), respectively, add country-HS4 and year fixed effects. Columns (4), (5) and (6) in turn add market power ($MP_{i,j}$), PTA import share ($PTA\_IM_{i,j,t}$) and log real per capita GDP ($y_{i,t}$) as respective covariates. Finally, column (7) treats market power as endogenous.

The counter-cyclicality of overhang emerges in columns (3)-(6) once year fixed effects are included. Despite column (5) indicating that overhang is lower when a greater share of product-level imports are sourced from PTA partners, as one would expect given our motivation in Section 2, controlling for PTA import share barely affects the estimated degree of cyclicality. Similarly, column (4) shows that controlling for market power does not affect the estimated degree of cyclicality. Column (6) on the other hand shows that controlling for log real per capita GDP strengthens the economic and statistical significance of the counter-cyclicality. The positive coefficient on $y_{i,t}$, together with its upward trending nature and the downward trend in applied tariffs, suggests countries with stronger per capita income growth tended to reduce applied tariffs more.

Interestingly, given the importance placed on the role of market power by the prior literature (e.g. Bagwell and Staiger (2011), Ludema and Mayda (2013), Nicita et al. (2013) and Beshkar et al. (2014)), column (4) suggests market power is not a statistically significant

[18] Again, observations within these clusters where the applied tariff did not change from the prior year are excluded from Panel B.

determinant of overhang. Note that we are using country-HS4 fixed effects and market power is country-product specific but time invariant. These results are thus saying that differences in a country's market power across HS6 products within an HS4 sector do not help explain why a country's overhang for HS6 products differ from the country's average overhang across time and products within the HS4 sector. This differs with prior work (e.g. Bagwell and Staiger (2011), Ludema and Mayda (2013), Beshkar et al. (2014)) that relies on differences in market power across HS6 products within broader two-digit HS2 industries.

Prior literature has treated market power as endogenous (e.g. Nicita et al. (2013) and Beshkar et al. (2014)). However, any such endogeneity is unlikely to cause problems in terms of estimating the cyclicality of overhang because columns (3) and (4) indicate that market power is essentially uncorrelated with the business cycle. Nevertheless, we use instrumental variables estimation in column (7). Following Nicita et al. (2013) and similar to Beshkar et al. (2014), we instrument for market power using product-level global averages of import demand elasticity from the view of the importer and export supply elasticity from the view of the exporter. These instruments appear to do well based on various specification tests. Based on the Kleibergen-Paap rk LM statistic, we easily reject the null that the effect of market power is unidentified (p-value of .025). Combined with a Kleibergen-Paap rk Wald F-statistic of 3.852, this suggests that the instruments appear strongly related to the endogenous regressor. We also cannot reject the null that the instruments are exogenous based on Hansen's J test of overidentification (p-value of 0.814). However, despite the instruments performing well, the endogeneity test (based on comparing two Sargan-Hansen statistics) cannot reject the null that market power is actually exogenous (p-value of 0.168). Thus, as market power is uncorrelated with our regressor of interest and we cannot reject the null that it is indeed exogenous, we treat market power as exogenous moving forward. In any case, the sign and statistical significance of the coefficients are preserved with instrumentation.

In addition to the sign and statistical significance of the coefficient estimate on $BC_{i,t-1}$, the economic magnitude of the counter-cyclicality is also of interest. As discussed in Section 3.1, the average gap between a country's maximum and minimum value of $BC_{i,t-1}$ over our sample period is 0.053, while the gap is 0.086 for a country that is 1 standard deviation above the mean. This provides measures of the magnitude of business cycle fluctuations and one could, intuitively, think of 0.053 as a proxy for the average fluctuation between the peak of the boom and the trough of the recession. The point estimate of -10.94 for the coefficient on $BC_{i,t-1}$ then implies that the fluctuation in overhang between the peak of the boom and the trough of the recession is about 0.58% points and represents about 16.5% of the average magnitude of applied tariff changes.[19] For a country with business cycle fluctuations

[19] Table 1 shows the average magnitude of applied tariff changes is about 3.5% points.

1 standard deviation above the mean, this becomes about 27% of the average magnitude of applied tariff changes. From these perspectives, business cycle fluctuations explain a non-trivial, but not overwhelming, portion of temporal applied tariff fluctuations. Thus, the pro-cyclicality evident in Table 2 appears both statistically and economically significant.

The primary motivation of this paper is to analyze applied tariff fluctuations yet, despite excluding any country-product observations where the tariff binding changed over the sample, Table 2 directly addresses the cyclicality of overhang rather than applied tariffs. The primary advantage of this approach is that PPML estimation can take into account the constraint whereby WTO rules imply that the applied tariff cannot exceed the tariff binding and thus overhang must be non-negative. Table 3 presents these PPML results with each column of Table 3 having the same interpretation as the analogous column of Table 2.

Importantly, Table 3 shows that the counter-cyclicality of overhang observed under OLS is not driven by the inability of OLS to recognize the non-negativity constraint of overhang. Specifically, column (6) shows that the counter-cyclicality of overhang is preserved under PPML estimation although statistical significance is now at the 10% level rather than the 5% level. This lower level of statistical significance is not surprising given that our PPML standard errors are more conservative than what we see as the appropriate two-way clustered standard errors that we use under OLS (see Section 2).

The magnitude of overhang counter-cyclicality given by the PPML estimates is very similar to that from the OLS estimates. The business cycle point estimate of $-.678$ in column (6) says that an increase in $BC_{i,t-1}$ of .01 is associated with a 0.678% fall in overhang. Thus, at the mean level of overhang of 15.35% points, the average business cycle fluctuation of 0.053 would be associated with a fall in overhang of 0.55% points, which is slightly lower than the OLS estimate of 0.58% points. Thus, the explicit consideration that countries cannot raise their applied tariffs above the tariff binding does not alter the main result that applied tariffs are pro-cyclical.

In terms of the other covariates, the PPML results tell a similar story to the OLS results. Like the OLS results, temporal fluctuations in overhang are not systematically related to market power but are negatively related PTA import share. However, although controlling for log real per capita GDP is helpful in isolating the effect of the business cycle, log real per capita GDP is not itself statistically significant at conventional levels.

Table 4 analyzes robustness of overhang counter-cyclicality by varying the sample used under OLS (Panel A) and PPML (Panel B). Column (1) adds back two types of observations: i) overhang observations $v_{i,j,t}$ where the applied tariff was subject to phase-in because of the Uruguay Round or the Information Technology Agreement in year t and ii) overhang observations $v_{i,j,t}$ where the tariff binding varied over the sample period. Column (2) excludes agriculture. Column (3) excludes observations of new WTO members (those that joined after 1995). Finally, column (4) excludes observations of the EU and China.[20]

The robustness exercises strongly support the overhang counter-cyclicality of the baseline results. Of particular note are the results under OLS in column (3) where we exclude new WTO members. Specifically, the degree of counter-cyclicality is now nearly 40% greater than under the baseline OLS analysis and statistically significant at the 1% level. Intuitively, this is perhaps not surprising because, on average, new WTO members have lower tariff bindings than original WTO members (14.54% vs. 29.12%) and lower overhang (7% vs. 20.93%) which implies they have much less room to vary their applied tariffs. Nevertheless, the analogous PPML specification says that the cyclicality of overhang for original WTO members is only about 10% greater than the baseline PPML analysis.

4.2 The pro-cyclicality of applied tariffs

Intuitively, the result that overhang is counter-cyclical should in turn imply that applied tariffs are pro-cyclical. This is especially so since we restrict the sample to country-products where the tariff binding is constant over the sample period. In this section, we explore the cyclicality of applied tariffs directly by using the applied tariff $\tau_{i,j,t}$ as the dependent variable rather than overhang $v_{i,j,t}$.

Previewing the results, our earlier interpretation of overhang counter-cyclicality as applied tariff pro-cyclicality is supported by the applied tariff specifications. Indeed, the similarity of the OLS results for overhang and applied tariffs is nearly by construction. Specifically, with country-HS6 fixed effects rather than country-HS4 fixed effects the absolute value of the estimates would be identical regardless of whether the dependent variable was overhang $v_{i,j,t}$ or the applied tariff $\tau_{i,j,t}$.[21] However, our use of product-level control variables, i.e. market power and PTA import share, prevent the use of country-HS6 fixed effects. Nevertheless, it is indeed unsurprising that the overhang and applied tariff results are different but very close in the OLS specifications. In contrast, the PPML estimations using overhang and applied tariffs as the dependent variable are substantively different specifications. As explained in the previous section, the non-negativity constraint in the overhang PPML specifications ex-

[20] We exclude the EU because EU applied tariffs are decided at the regional level while economic growth is arguably impacted more by country-level variables. We exclude China to ensure that results are not driven solely by its rapid economic growth.

[21] Given our sample has already restricted the observations to have constant tariff bindings over the sample, this is easily seen by demeaning the left hand side of equation (1) at the country-HS6 level and doing the same thing after replacing overhang with the applied tariff as the dependent variable. Demeaning the left hand side of equation (1) yields $v_{i,j,t} - \frac{1}{10}\sum_{t=2000}^{2009} v_{i,j,t} = (\bar{\tau}_{i,j,t} - \tau_{i,j,t}) - \frac{1}{10}\sum_{t=2000}^{2009}(\bar{\tau}_{i,j,t} - \tau_{i,j,t}) = -\left(\tau_{i,j,t} - \frac{1}{10}\sum_{t=2000}^{2009}\tau_{i,j,t}\right)$. And, apart from the change in sign, this is clearly the identical result obtained by demeaning the left hand side of (1) after replacing $v_{i,j,t}$ with $\tau_{i,j,t}$.

plicitly recognizes that applied tariffs cannot exceed the tariff binding. On the other hand, the non-negativity constraint in the PPML specifications with the applied tariff as the dependent variable explicitly recognizes that applied tariffs must be non-negative. Thus, while OLS recognizes neither the non-negativity constraint on overhang nor the non-negativity constraint on applied tariffs, the overhang PPML specifications account for the non-negativity of overhang and the applied tariff PPML specifications account for the non-negativity of applied tariffs.

Table 5 presents the results with the applied tariff as the dependent variable. Apart from the fact that the dependent variable is the applied tariff rather than overhang, Panels A and B of Table 5 are analogous to, respectively, Tables 2 and 3. The results are very similar to earlier results. First, applied tariffs are pro-cyclical once year fixed effects are included (i.e. from column (3) onwards) with the statistical significance in columns (6) at the 5% level for OLS and the 10% level for PPML. Second, while market power is statistically insignificant and PTA import share is positively related to applied tariffs, both leave the magnitude of the business cycle coefficient essentially unchanged. Third, the OLS IV specification tests tell the same story as the previous section. These tests suggest the instruments are strongly correlated with the potentially endogenous market power regressor and that one cannot reject the null that the instruments are exogenous, but also that one cannot reject the null that market power is in fact exogenous. So, again, we focus on treating market power as exogenous hereafter.

Unlike the OLS results, the economic significance of the PPML business cycle coefficient varies in a non-trivial way between the applied tariff and overhang specifications. This difference is possible because the nature of the non-negativity constraint recognized by PPML is different in the applied tariff specification than the overhang specification. The business cycle point estimate of 1.007 in column (6) of Panel B says an increase in $BC_{i,t-1}$ of .053 is associated with a 0.42% point increase in the applied tariff when the applied tariff is at its mean of 7.9%. This is somewhat lower than the 0.55% point increase suggested in the PPML overhang specification. The 0.42% point increase represents about 12.1% of the mean applied tariff change. The more conservative estimates of the cyclicality under the applied tariff PPML specification suggest that the non-negativity constraint on the applied tariff may be empirically more important to consider than the overhang non-negativity constraint.

Before moving on, it is useful to note that the applied tariff results are robust to the various sample selection robustness checks explored in Table 4. Each column of Panels C and D in Table 5 corresponds to the same robustness check as the analogous column of Table 4. Like Table 4, perhaps the most interesting feature of Panels C and D in Table 5 is that the cyclicality of the applied tariff is substantially larger for original WTO members.

4.3 Cyclicality and level of development

As discussed in Section 3.1, developing countries enjoy significantly higher overhang than developed countries. Further, the fact that developing countries are much more likely than developed countries to move the applied tariff on a given product up and down over time suggests that they exploit the greater applied tariff flexibility implied by the higher overhang. Thus, we now investigate how the cyclicality of overhang and applied tariffs depends on the level of development. We classify a country as either developed or developing based on historical categorizations by the World Bank (see Table A1).

Table 6 presents the results and suggests that the cyclicality discussed in Sections 4.1 and 4.2 is driven by developing countries. The absolute values of the business cycle point estimates for developing countries in Table 6 are 15-35% larger than the pooled estimates in Tables 2, 3 and Panels A and B of Table 5. For developed countries, the sign of the business cycle point estimates are consistent with those of developing countries, i.e. counter-cyclical overhang and pro-cyclical applied tariffs, but these estimates are generally far from statistically significant. That is, applied tariffs and overhang appear to be acyclical in developed countries. Thus, the cyclicality of earlier sections is driven by the behavior of developing countries.[22]

5 Sensitivity analysis

We test the robustness of the results in Section 4 to including both additional control variables and some previously excluded observations. Table 7 presents the results of the robustness exercises but, for the sake of brevity, omits the results for the market power, PTA import share and log real per capita GDP coefficients. Again for brevity, Table 7 also omits the results for the pooled sample of developing and developed countries. Thus, Table 7 not only investigates the robustness of our cyclicality results but also the robustness of the dichotomy between developed and developing countries illustrated in Table 6.[23]

We first analyze whether the cyclicality results are robust to controlling for import surges and including observations with zero tariff bindings. Then we consider whether the results depend on certain characteristics, specifically i) Great Recession vs. pre-Great Recession

[22] With a few exceptions, the coefficient estimates for the other variables are similar to the baseline results. The exceptions are that the market power coefficient is negative and statistically significant at the 10% level for the applied tariff estimations for developing countries, and the coefficient on the log real per capita GDP variable flips sign for developed countries but is not statistically significant.

[23] The results for the pooled sample are available on request. The economic and statistical significance of the results mirror the pattern in Table 6 vs. Tables 2, 3 and 5. That is, like Section 4, the results of the pooled sample are driven by the developing countries.

years, ii) products under a TTB vs. products not under a TTB, iii) intermediate goods vs. non-intermediate goods, iv) products with tariff bindings vs. products without tariff bindings and v) the global business cycle. Finally, we analyze robustness to measures of the business cycle using alternate filtering techniques.

Import surges. Using a model of self-enforcing trade agreements, Bagwell and Staiger (1990) show that applied tariffs should be increasing in import surges and decreasing in the volatility of import surges. Recent empirical work has implemented these import surge variables as the lagged change in imports, $\Delta IM_{i,j,t-1}$ and $sd\Delta IM_{i,j,t-1}$, and the lagged change in the share of world imports, $\Delta IM^{share}_{i,j,t-1}$ and $sd\Delta IM^{share}_{i,j,t-1}$ (see Section 3.1). Using either measure, Bown and Crowley (2013b) find evidence that, indeed, the likelihood and size of tariffs under temporary trade barriers are increasing in import surges and decreasing in their volatility. Using the latter measure, Groppo and Piermartini (2014) find similar evidence for the likelihood and magnitude of applied tariff increases.

Since it is *a priori* plausible that our pro-cyclical applied tariff results could be driven by import surges being positively correlated with the business cycle, we ensure that our results are robust to controlling for import surges. Panel A of Table 7 presents the results using the lagged change in imports as the measure of import surges while Panel B uses the lagged change in the share of world imports as the measure. These results clearly demonstrate that the cyclicality found in earlier sections is not due to any correlation between the business cycle and import surges. Indeed, there is very minimal effect on the magnitude of cyclicality in Panels A and B relative to our baseline results, indicating that there is little correlation between the business cycle and import surges.

The coefficients on the import surge variables themselves reflect the spirit of Bown and Crowley (2013b) and Groppo and Piermartini (2014) in that the volatility of import surges is negatively related to applied tariffs for developing countries (although the relationship is not statistically significant in the OLS overhang specification using lagged import changes). However, we find no such statistically significant relationship for developed countries. Furthermore, our results regarding the import surge itself differ from Bown and Crowley (2013b) and Groppo and Piermartini (2014). For developing countries, we only find a statistically significant relationship when using lagged import changes, but using this measure suggests that import surges are associated with *lower* applied tariffs. For developed countries, there is generally no statistically significant relationship although the point estimates for the applied tariff specifications suggest lagged import surges are associated with higher applied tariffs.

Zero tariff bindings. Panel C expands the baseline sample to include products that have a zero tariff binding. These were excluded from the baseline analysis to ensure the degree of cyclicality was not clouded by observations where, according to WTO rules, countries have no flexibility to adjust applied tariffs and therefore cyclicality is ruled out *a priori*. However, since our cyclicality results are driven by developing countries and, per Table A3, only 2.2% of developing country observations involve zero tariff bindings, it is not surprising that the degree of cyclicality is only slightly muted by including zero tariff bindings.

Great recession. Panel D investigates the impact of the Great Recession on our cyclicality results by expanding the sample to include 2010 and 2011. We include a dummy GR_t which is equal to 1 in 2010 and 2011 and equal to zero otherwise and also add the interaction term $GR_t \cdot BC_{i,t-1}$.[24] Unsurprisingly, the business cycle coefficients are virtually unchanged as their interpretation is unchanged from the baseline specifications: the degree of cyclicality for the pre-Great Recession years. The negative coefficient on the GR_t dummy is also unsurprising given that this dummy replaces the 2010 and 2011 year fixed effects and applied tariffs are, on average, declining over the sample period including the Great Recession years of 2010 and 2011. The sign on the interaction effect $GR_t \cdot BC_{i,t-1}$ suggests that the pro-cyclicality of applied tariffs was mitigated during the Great Recession. Indeed, in the OLS applied tariff specification, the point estimate of $BC_{i,t-1}$ in the Great Recession years is $-26.63 + 15.1 = -11.53$ which suggests applied tariff counter-cyclicality. However, as the F-test p-values indicate, this effect is never statistically different from zero at conventional levels. Thus, consistent with recent work by Gawande et al. (2011) and Kee et al. (2013), our results seem to indicate acyclicality of applied tariffs during the Great Recession.

Temporary Trade Barriers (TTBs). Panel E investigates how our results are affected by recognizing that countries can also impose protection in the form of TTBs. We include a dummy $TTB_{i,j,t}$ which is equal to 1 in year t if country i imposes a TTB on product j and also add the interaction term $TTB_{i,j,t} \cdot BC_{i,t-1}$. We find no statistically significant relationships for developed countries. The point estimates for $TTB_{i,j,t}$ in developing countries suggest that developing countries tend to impose TTBs on products that have high applied tariffs and thus applied tariffs and TTBs could be viewed as complements. In this specification, $BC_{i,t-1}$ represents the cyclicality when a product is not subject to a TTB. Given that only 1% of developing country observations are subject to TTBs (see Table A3), it is unsurprising that the developing country $BC_{i,t-1}$ coefficient estimates are virtually unchanged from the baseline results. Interestingly, the point estimates on the interaction term suggest that the presence of a TTB greatly reduces the cyclicality of applied tariffs leaving a negligible point estimate for $BC_{i,t-1}$ when products are subject to a TTB. Indeed, the F-test p-values indicate that the cyclicality for products subject to a TTB is not statistically different from zero.

[24] If we extend the sample through 2010-11 and re-estimate the specifications in Table 6, we find the same results: overhang is counter-cyclcial and applied tariffs are pro-cyclical in developing countries (at the 10% level for OLS and PPML) but acyclical in developed countries.

Intermediate goods. Panel F investigates whether the degree of cyclicality depends on whether a good is an intermediate good. We include a dummy $Intermed_j$, which is equal to 1 if product j is an intermediate good (according to Rauch (1999)), and also add the interaction term $Intermed_j \cdot BC_{i,t-1}$. Not surprisingly given the presumed preference of final-good producers for low tariffs on intermediate inputs, the point estimates for $Intermed_j$ show that developing and developed countries tend to have lower applied tariffs and tariff bindings on intermediate goods than non-intermediate goods; the lower tariff bindings dominate for developed countries and generate lower overhang. The point estimates of cyclicality for non-intermediate goods in developing countries (i.e. $BC_{i,t-1}$) are somewhat larger than the baseline results while the point estimates of cyclicality for intermediate goods (i.e. $BC_{i,t-1} + Intermed_j \cdot BC_{i,t-1}$) are somewhat lower than the baselines results. Whether cyclicality is present for intermediate goods in developing countries is somewhat unclear with the F-test p-values strongly rejecting the null of no cyclicality for the OLS specifications (p-values of 0.029 and 0.026) but unable to reject the null of no cyclicality for the PPML specifications (p-values of 0.12 and 0.15).

Unbound tariffs. Panel G investigates whether cyclicality differs based on the existence of a tariff binding. In part, this is motivated by recent empirical and theoretical work including Handley and Limão (2012), Groppo and Piermartini (2014) and Handley (2014). We include a dummy $Unbound_{i,j}$, equal to 1 if country i imposes no tariff binding on j, and also add the interaction term $Unbound_{i,j} \cdot BC_{i,t-1}$. Note that there are no overhang specifications here because, by definition, calculating overhang requires the presence of a tariff binding. According to the results in Panel G, developing countries tend to set higher applied tariffs on unbound relative to bound products. Moreover, the pro-cyclicality of applied tariffs is preserved both for bound and unbound products (with F-test p-values of 0.024 and 0.095). Although the PPML specification for developed countries provides evidence of pro-cyclicality for unbound products (F-test p-value of 0.09), the effect is economically negligible.

Global business cycle. Panel H considers whether cyclicality depends on the global business cycle. As described in Section 3.1, we compute a measure of the global business cycle from the perspective of the importer, $GBC_{i,t-1}$, by weighting the business cycle of all other countries in the world (not only including the countries in our sample) using time-invariant import weights from a year prior to the importer entering our sample. We also include the interaction term $GBC_{i,t-1} \cdot BC_{i,t-1}$. Except for the PPML overhang specification for developed countries, this global business cycle variable is statistically insignificant at the 10% level. Additionally, the interaction term $GBC_{i,t-1} \cdot BC_{i,t-1}$ is nowhere conventional levels of statistical significance in any specification. Indeed, the point estimates are virtually unchanged when omitting the interaction term. Thus, we conclude that this global business cycle measure is not an important determinant of country level applied tariff fluctuations.

Alternate measures of the business cycle. Finally, Panel I investigates robustness of the cyclicality results to alternate filtering techniques for computing the business cycle variable. Using both the Baxter-King and the Christiano-Fitzgerald filters leaves the results intact, although the estimates using the Christiano-Fitzgerald filtering are slightly smaller in magnitude and statistically significant at the 10% level using both OLS and PPML estimation.[25] This suggests that the results are robust to different filtering techniques.

6 Conclusion

Conventional wisdom says that applied tariffs are counter-cyclical (and, in turn, binding overhang is pro-cyclical). Using a product-level panel dataset with 72 countries over the years 2000-2011, our results suggest the opposite: applied tariffs are pro-cyclical (and binding overhang is counter-cyclical). While we find no evidence for the conventional wisdom that applied tariffs are counter-cyclical, which is consistent with other recent work suggesting the acyclicality of applied tariffs in various contexts (Gawande et al. (2011), Kee et al. (2013) and Rose (2013)), our results go further than previous work because we find evidence of applied tariff pro-cyclicality. Moreover, our results emerge despite controlling for numerous variables emphasized in the recent theoretical and empirical literature as important determinants of applied tariffs including market power, import surges and the share of imports sourced from PTA partners.

Upon further investigation, we isolate some of the characteristics associated with pro-cyclicality. Most importantly, we find the pro-cyclical applied tariff results are driven by developing countries. That is, applied tariffs are acyclical in developed countries. Within developing countries, the pro-cyclical applied tariff results are driven by the pre-great recession years and products that are not subject to TTBs. In other words, even within developing countries, applied tariffs were acyclical during the Great Recession and are acyclical for products under the purview of TTBs. On the other hand, the pro-cyclicality of applied tariffs within developing countries does not depend on the importer's perception of the global business cycle and does not depend on whether or not the product is subject to a tariff binding.

The result that applied tariffs are pro-cyclical in developing countries but acyclical in developed countries suggests that the political economy mechanisms through which pres-

[25] We implement the Christiano-Fitzgerald filter with a third order symmetric moving average (as is standard with the Baxter-King filter) to ensure it is robust to second order trends.

sures for protection impact trade policy may differ depending on the level of a country's development. Theoretical explanations for the pro-cyclicality within developing countries and the dichotomy between developed and developing countries represent avenues for future research.

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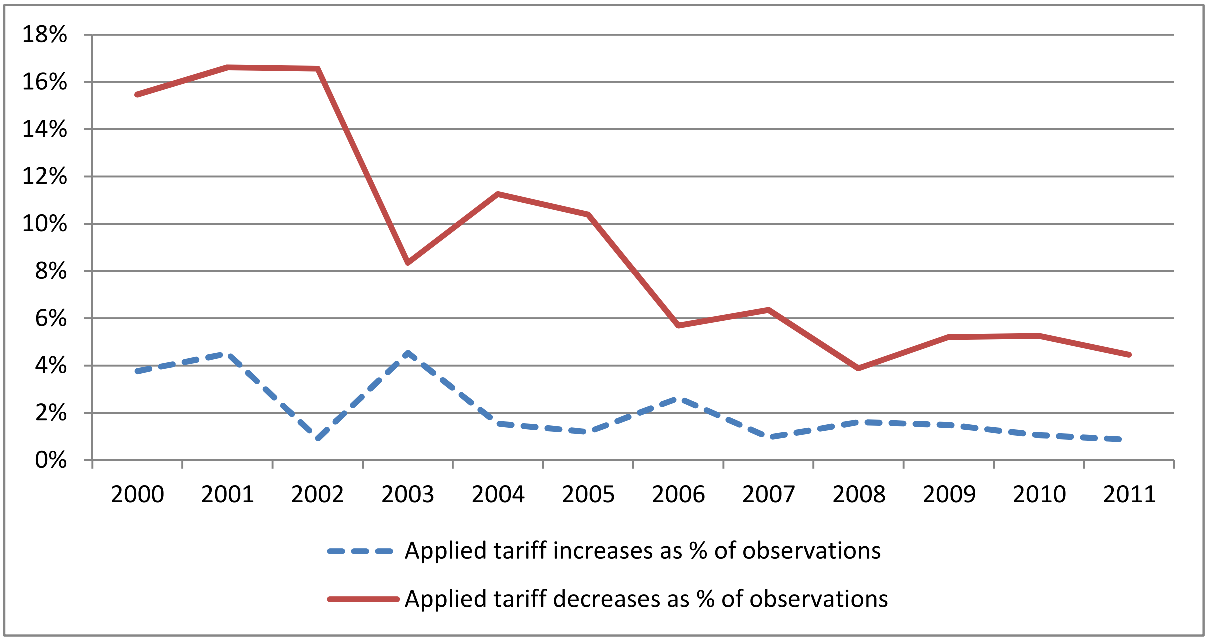
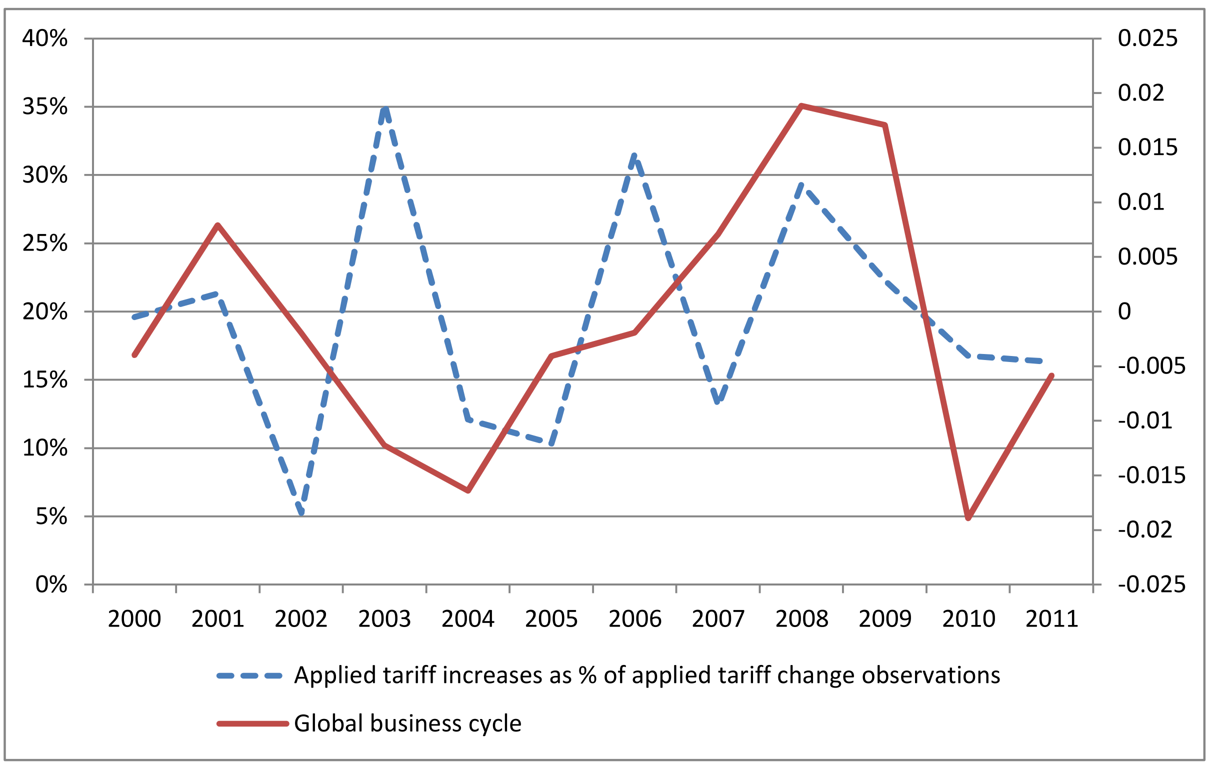
A Appendix

Figure 1: Temporal pattern of applied tariff changes

Panel A: Temporal pattern of applied tariff increeases and decreases



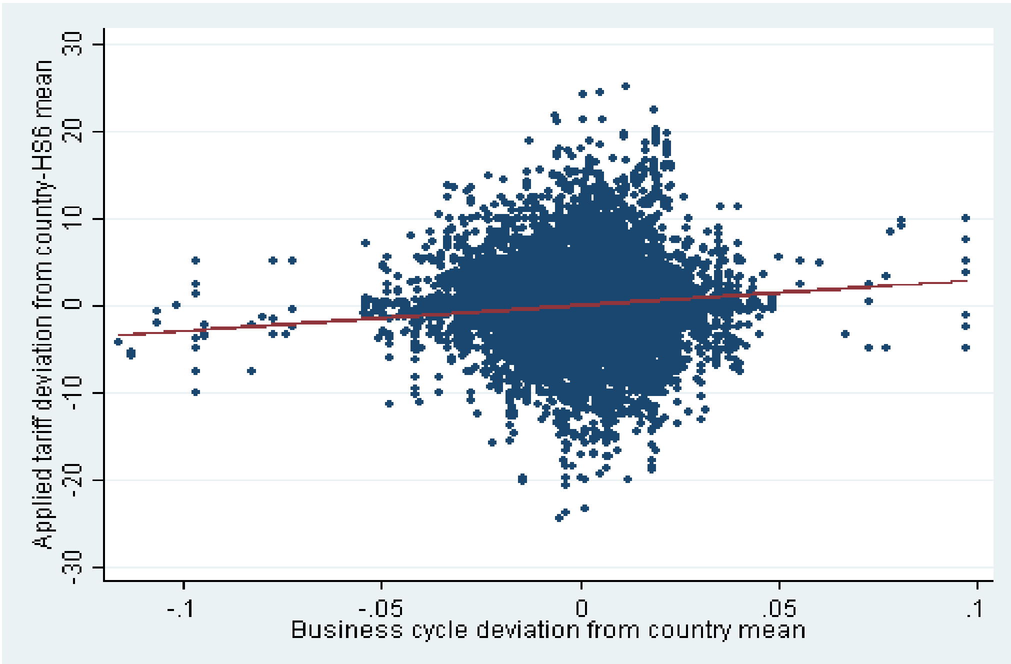
Panel B: Relationship between tariff increases and global business cycle



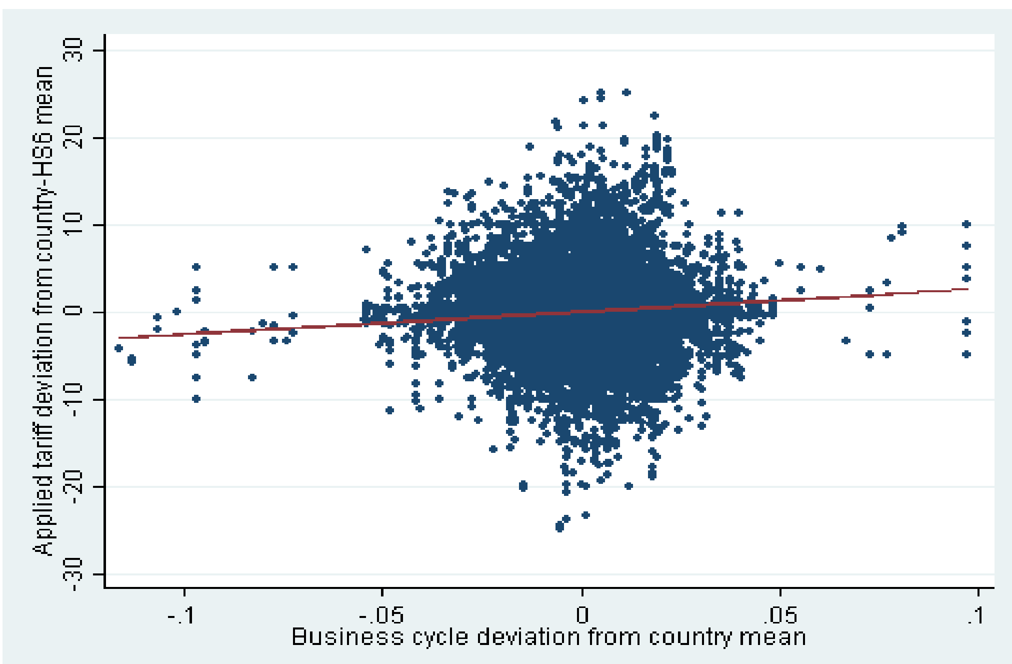
Notes: The sample used extends that described in Section 3.1 through 2011 and excludes missing overhang observations. The global business cycle in panel B is a simple average of the $BC_{i,t-1}$ values in the sample.

Figure 2: Preliminary evidence that applied tariffs could be pro-cyclical

Panel A: Applied tariff changes for country-products where applied tariff rises and falls over sample



Panel B: Applied tariff changes for country-products where applied tariff changes over sample



Notes: The sample used takes that described in Section 3.1 and excludes missing overhang observations. Both panels only include observations where the applied tariff changed relative to the prior year. Additionally, Panel A only includes observations from country-product clusters where the applied tariff moved up and down over the sample period.

Table 1: Frequency and magnitude of applied tariff changes

A. Frequency and magnitude of applied tariff changes at country-product-year level

	Pooled			Developing			Developed		
	N	%	Ave. size	N	%	Ave. size	N	%	Ave. size
Unchanged	1,304,218	88.32		821,135	84.97		483,083	94.66	
Changed	172,446	11.68	-2.11	145,199	15.03	-2.25	27,247	5.34	-1.38
Total	1,476,664	100		966,334	100		510,330	100	

B. Frequency and magnitude of directional applied tariff changes at country-product-year level

	Pooled			Developing			Developed		
	N	%	Ave. size	N	%	Ave. size	N	%	Ave. size
Applied tariff decrease	139,884	9.47	-3.41	118,812	12.30	-3.61	21,072	4.13	-2.29
Applied tariff unchanged	1,304,218	88.32		821,135	84.97		483,083	94.66	
Applied tariff increase	32,562	2.21	3.49	26,387	2.73	3.90	6,175	1.21	1.72
Total	1,476,664	100		966,334	100		510,330	100	

C. Frequency of directional applied tariff changes at country-product level

	Pooled		Developing		Developed	
	N	%	N	%	N	%
Applied tariff only decreases	68,286	36.93	46,080	38.23	22,206	34.50
Applied tariff always unchaged	68,728	37.17	34,995	29.03	33,733	52.40
Applied tariff only increases	6,209	3.36	2,859	2.37	3,350	5.20
Applied tariff increaases and decreases	41,688	22.54	36,605	30.37	5,083	7.90
Total	184,911	100	120,539	100	64,372	100

Notes: The sample used is that described in Section 3.1 but excluding observations with misssing overhang (due to either missing applied tariff or missing tariff binding).

Table 2: Cyclicality of overhang using fixed effects OLS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$BC_{i,t-1}$	3.683	4.1767	-8.1487†	-8.1487†	-8.0771†	-10.9412†	-13.1931†
	21.5777	3.5533	4.0956	4.0956	4.0922	4.5882	5.3682
$MP_{i,j}$				0.0019	0.0026	0.0025	1.1444
				0.0061	0.0061	0.0061	0.906
$PTA\_IM_{i,j,t}$					-0.4185*	-0.3979*	-0.6220*
					0.1173	0.108	0.2023
$y_{i,t}$						5.6403*	5.7994†
						2.1442	2.4378
N	1292872	1292811	1292811	1292811	1292811	1292811	1036308
Country-HS4 FE	No	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes	Yes
Underidentification p-value							0.025
Weak instrument rk F stat							3.852
Overidentification p value							0.814
Regressor endogeneity p-value							0.168

Notes: The sample is that described in Section 3.1. Two-way clustered standard errors are used by clustering at the country-year and country-HS4 level. Market power is treated as endogenous in column (7); the instruments are the global average import demand elasticity and the global average export supply elasticity from the perspective of the exporter.
‡ p<0.10, † p<0.05, * p<0.01

Table 3: Cyclicality of overhang using fixed effects PPML

	(1)	(2)	(3)	(4)	(5)	(6)
$BC_{i,t-1}$	0.2106	0.2131	-0.4531	-0.4531	-0.4493	-0.6778‡
	0.7699	0.2316	0.2867	0.2868	0.2855	0.3998
$MP_{i,j}$				0.0002	0.0002	0.0002
				0.0005	0.0005	0.0005
$PTA\_IM_{i,j,t}$					-0.0303†	-0.0262*
					0.0129	0.0097
$y_{i,t}$						0.3985
						0.3365
N	1292872	1177210	1177210	1177210	1177210	1177210
Country-HS4 FE	No	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes

Notes: The sample is identical to that in Table 2. Standard errors are clustered at the country level.
‡ p<0.10, † p<0.05, * p<0.01

Table 4: Sample selection robustness for cyclicality of overhang

A. FE OLS

	(1)	(2)	(3)	(4)
$BC_{i,t-1}$	-11.5980*	-11.8254†	-15.3255*	-12.5539*
	4.315	4.8874	5.3725	4.8052
$MP_{i,j}$	0.0049	0.0038	0.004	0.0031
	0.0076	0.0052	0.0073	0.0068
$PTA\_IM_{i,j,t}$	-0.4347*	-0.4361*	-0.4792*	-0.4208*
	0.1126	0.101	0.12	0.1074
$y_{i,t}$	5.2823*	5.8042†	8.6312*	7.6411*
	1.9813	2.2946	3.114	2.5544
N	1381684	1181830	1112416	1233408
Country-HS4 FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

B. FE PPML

	(1)	(2)	(3)	(4)
$BC_{i,t-1}$	-0.6433‡	-0.7671‡	-0.7466‡	-0.6785‡
	0.3382	0.4614	0.4288	0.4
$MP_{i,j}$	0.0004	0.0003	0.0003	0.0002
	0.0006	0.0004	0.0005	0.0005
$PTA\_IM_{i,j,t}$	-0.0258*	-0.0304*	-0.0271*	-0.0262*
	0.0093	0.0109	0.0104	0.01
$y_{i,t}$	0.3278	0.4131	0.3654	0.399
	0.2728	0.3644	0.3659	0.337
N	1296362	1112636	1069529	1201872
Country-HS4 FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Notes: The columns modify the sample from Tables 2 and 3 in the following ways
(1) Includes country-product-year observations subject to phase-in (Uruguay round or Information Technology Agreement) and includes country-product observations where the tariff binding changes over the sample period.
(2) Excludes agriculture.
(3) Excludes new WTO members.
(4) Excludes EU and China.
For standard errors, see Table 2 (OLS) and Table 3 (PPML).
‡ p<0.10, † p<0.05, * p<0.01

Table 5: Cyclicality of applied tariff

A: FE OLS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$BC_{i,t-1}$	-3.0133	-4.2859	8.3928†	8.3927†	8.2942†	11.2369†	13.5291†
	9.5282	3.5697	4.1021	4.1021	4.0991	4.596	5.3619
$MP_{i,j}$				0.002	0.0011	0.0012	1.1148
				0.012	0.012	0.012	1.1752
$PTA\_IM_{i,j,t}$					0.5759*	0.5547*	0.4070‡
					0.1078	0.0972	0.2323
$y_{i,t}$						-5.7952*	-6.0037†
						2.1397	2.4204
N	1292872	1292811	1292811	1292811	1292811	1292811	1036308
Underidentification p-value							0.025
Weak instrument rk F stat							3.852
Overidentification p value							0.303
Regressor endogeneity p-value							0.278

B: FE PPML

	(1)	(2)	(3)	(4)	(5)	(6)
$BC_{i,t-1}$	-0.3501	-0.4493	0.8158‡	0.8158‡	0.8065‡	1.0069‡
	0.6779	0.4951	0.4876	0.4876	0.486	0.5563
$MP_{i,j}$				0.0002	0.0001	0.0001
				0.0016	0.0016	0.0016
$PTA\_IM_{i,j,t}$					0.0515*	0.0492*
					0.0193	0.0164
$y_{i,t}$						-0.5084
						0.469
N	1292872	1137904	1137904	1137904	1137904	1137904

C: FE OLS robustness

	(1)	(2)	(4)	(5)
$BC_{i,t-1}$	11.7079*	12.1646†	15.5563*	12.7905*
	4.3351	4.8992	5.3842	4.8172
$MP_{i,j}$	0.0009	-0.0076‡	0.0006	0.0014
	0.0147	0.0039	0.0148	0.0132
$PTA\_IM_{i,j,t}$	0.5613*	0.5547*	0.627*	0.5792*
	0.1016	0.1025	0.1085	0.0964
$y_{i,t}$	-5.3807*	-5.9755*	-8.7753*	-7.6948*
	1.9751	2.2921	3.1249	2.5636
N	1381684	1181830	1112416	1233408

D: FE PPML robustness

	(1)	(2)	(4)	(5)
$BC_{i,t-1}$	0.9849†	1.1097‡	1.3340†	1.1490†
	0.4886	0.605	0.5996	0.5703
$MP_{i,j}$	0.0001	-0.001	0	0.0001
	0.002	0.0006	0.002	0.0018
$PTA\_IM_{i,j,t}$	0.05*	0.0498*	0.0527*	0.0504*
	0.0169	0.0175	0.0174	0.0158
$y_{i,t}$	-0.44	-0.541	-0.7358	-0.7105
	0.403	0.5085	0.6128	0.5469
N	1221351	1042717	962531	1078824

Notes: Panels A and B are the same as Tables 2 and 3 except that the dependent variable is now the applied tariff rather than overhang. Panels C and D are identical to Table 4 except that the dependent variable is the applied tariff rather than overhang. All specifications include year and country-HS4 fixed effects.

‡ p<0.10, † p<0.05, * p<0.01

Table 6: Cyclicality and level of development

	Developing				Developed			
	Overhang		Applied tariff		Overhang		Applied tariff	
	FE OLS	**FE PPML**	**FE OLS**	**FE PPML**	**FE OLS**	**FE PPML**	**FE OLS**	**FE PPML**
$BC_{i,t-1}$	-14.5105†	-0.8502‡	14.8400†	1.1424‡	-1.4333	-0.1987	1.622	0.3023
	5.86	0.5002	5.8752	0.6143	1.7283	0.1384	1.7378	0.356
$MP_{i,j}$	0.0108	0.0006	-0.0109‡	-0.0012‡	-0.0136	-0.0022	0.0248	0.0041
	0.0078	0.0005	0.006	0.0007	0.0093	0.0019	0.0335	0.0059
$PTA\_IM_{i,j,t}$	-0.5552*	-0.0300*	0.6653*	0.0504*	0.0827	0.0065	0.2532*	0.0618†
	0.1276	0.011	0.1196	0.0175	0.157	0.0175	0.0762	0.025
$y_{i,t}$	6.0294†	0.5787	-6.2534†	-0.5684	-0.9604	-0.0166	1.0005	0.2768
	2.8574	0.4575	2.8467	0.5434	0.8676	0.0804	0.8447	0.2399
N	938754	886101	938754	861742	353777	290771	353777	275676
Country-HS4 FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: The overall sample, before splitting it into developed and developing countries, is the same as Table 2. The standard errors are the same as used in Table 2 (OLS) and Table 3 (PPML).
‡ p<0.10, † p<0.05, * p<0.01

Table 7: Robustness

Panel A: Import surges as lagged changes in imports

	Developing				Developed			
	Overhang		Applied tariff		Overhang		Applied tariff	
	FE OLS	FE PPML	FE OLS	FE PPML	FE OLS	FE PPML	FE OLS	FE PPML
$BC_{i,t-1}$	-15.1640†	-0.8953‡	15.4595†	1.1686‡	-1.9563	-0.2946	2.0222	0.3446
	6.1957	0.5338	6.2045	0.6252	2.2270	0.2081	2.2047	0.5345
$\Delta IM_{i,j,t-1}$	0.0575†	0.0043‡	-0.0410	-0.0071†	0.0015	0.0087†	0.0028	0.0007
	0.0252	0.0022	0.0290	0.0032	0.0017	0.0038	0.0031	0.0007
$sd\Delta IM_{i,j,t-1}$	-0.0592	-0.0040	-0.1024†	-0.0138†	-0.0070	-0.0282	-0.0015	-0.0003
	0.0556	0.0111	0.0485	0.0069	0.0047	0.0178	0.0086	0.0014
N	836140	786906	836140	771169	306758	243598	306758	242229

Panel B: Import surges as lagged changes in share of world imports

	Developing				Developed			
	Overhang		Applied tariff		Overhang		Applied tariff	
	FE OLS	FE PPML	FE OLS	FE PPML	FE OLS	FE PPML	FE OLS	FE PPML
$BC_{i,t-1}$	-15.0492†	-0.8877‡	15.3304†	1.1614‡	-1.9549	-0.2931	2.0108	0.3412
	6.1541	0.5295	6.1610	0.6243	2.2302	0.2080	2.2085	0.5356
$\Delta IM_{i,j,t-1}^{Share}$	0.9287	-0.0130	-1.2649	-0.0994	-0.0607	-0.0249	0.7705†	0.1604
	1.2372	0.0448	1.2185	0.1319	0.1594	0.0376	0.3586	0.1094
$sd\Delta IM_{i,j,t-1}^{Share}$	3.6143†	0.2160*	-6.1475*	-0.6944*	0.5078	0.1156	-0.4563	-0.0979
	1.6800	0.0663	1.2180	0.1446	0.6216	0.2786	3.3060	0.5551
N	835072	785876	835072	770237	306598	243454	306598	242120

Panel C: Including zero tariff bindings

	Developing				Developed			
	Overhang		Applied tariff		Overhang		Applied tariff	
	FE OLS	FE PPML	FE OLS	FE PPML	FE OLS	FE PPML	FE OLS	FE PPML
$BC_{i,t-1}$	-14.2262†	-0.8469‡	14.6622†	1.1474‡	-1.072	-0.2075	1.1105	0.3014
	5.7756	0.4997	5.8082	0.6148	1.298	0.1386	1.2918	0.3547
N	966001	892632	966001	867228	510293	309946	510293	294114

Panel D: Great Recession

	Developing				Developed			
	Overhang		Applied tariff		Overhang		Applied tariff	
	FE OLS	FE PPML	FE OLS	FE PPML	FE OLS	FE PPML	FE OLS	FE PPML
$BC_{i,t-1}$	-14.7748†	-0.8345‡	15.0950†	1.1852‡	-1.5921	-0.2017	1.7702	0.3118
	6.0272	0.4867	6.0405	0.6324	1.6413	0.1392	1.6526	0.3596
GR_t	2.3312*	0.0109	-2.3359*	-0.1823	0.9227*	0.0809*	-0.9634*	-0.2141*
	0.8059	0.0823	0.8038	0.153	0.272	0.0259	0.2682	0.0767
$GR_t * BC_{i,t-1}$	25.801	1.2067	-26.6337	-1.3578	5.9711	0.2776	-6.7842	-1.713
	16.3939	1.1332	16.4237	1.92	5.2028	0.6111	5.1908	1.7099
N	1134785	1074283	1134785	1045930	430748	355223	430748	335867
F-test p-value	0.4546	0.6723	0.4347	0.9147	0.3594	0.8947	0.2931	0.3852

Table 7 (cont.): Robustness

Panel E: Temporary trade barriers

	Developing				Developed			
	Overhang		Applied tariff		Overhang		Applied tariff	
	FE OLS	FE PPML	FE OLS	FE PPML	FE OLS	FE PPML	FE OLS	FE PPML
$BC_{i,t-1}$	-14.7155†	-0.8608‡	15.0252†	1.1618‡	-1.4329	-0.1988	1.6239	0.3027
	5.8529	0.5015	5.8644	0.6183	1.7278	0.1382	1.7378	0.3554
$TTB_{i,j,t}$	-0.8623†	-0.0531*	0.8691†	0.0708†	-0.1039	-0.0553	-0.0048	-0.0025
	0.3518	0.0144	0.341	0.0291	0.0819	0.0583	0.1305	0.0212
$TTB_{i,j,t} * BC_{i,t-1}$	15.085	0.755	-13.8168	-1.0971	-0.6957	0.3489	-1.488	-0.2135
	13.1832	0.6577	13.0663	0.7659	3.7423	0.8047	3.1665	0.6402
N	938754	886101	938754	861742	353777	290771	353777	275676
F-test p-value	0.9803	0.8962	0.9357	0.9456	0.6119	0.8504	0.9707	0.9197

Panel F: Intermediate goods

	Developing				Developed			
	Overhang		Applied tariff		Overhang		Applied tariff	
	FE OLS	FE PPML	FE OLS	FE PPML	FE OLS	FE PPML	FE OLS	FE PPML
$BC_{i,t-1}$	-15.8007*	-0.9081‡	16.1093*	1.3522†	-2.0449	-0.2514‡	2.3466	0.4407
	5.7581	0.4829	5.7397	0.5988	1.8623	0.1422	1.8051	0.3256
$Intermed_j$	0.0591	0.0028	-0.8140*	-0.1041*	-0.3901†	-0.0397†	-0.3627*	-0.0900†
	0.1455	0.0129	0.1195	0.0340	0.1548	0.0196	0.0774	0.0367
$Intermed_j * BC_{i,t-1}$	2.4563	0.1053	-2.4670	-0.4205‡	0.9044	0.0725	-1.5390	-0.3925
	2.8114	0.1496	2.8098	0.247	1.0871	0.0906	0.9623	0.3384
N	920635	868112	920635	844635	345592	281974	345592	269015
F-test p-value	0.0292	0.1215	0.0264	0.1504	0.5399	0.2388	0.6644	0.9229

Panel G: Including unbound tariffs

	Developing		Developed	
	Applied tariff		Applied tariff	
	FE OLS	FE PPML	FE OLS	FE PPML
$BC_{i,t-1}$	17.7661*	1.2649‡	1.1644	0.2696
	6.2409	0.6546	1.5731	0.3491
$Unbound_{i.j}$	1.1508*	0.1465*	0.1906	0.041
	0.2366	0.0457	0.2999	0.0609
$Unbound_{i.j} * BC_{i,t-1}$	3.5439	0.3504	-1.3091	-0.0923
	12.6493	0.8044	1.8745	0.3456
N	1189408	1091615	432791	296707
F-test p-value	0.0236	0.0951	0.1254	0.0893

Panel H: Global business cycle

	Developing				Developed			
	Overhang		Applied tariff		Overhang		Applied tariff	
	FE OLS	FE PPML	FE OLS	FE PPML	FE OLS	FE PPML	FE OLS	FE PPML
$BC_{i,t-1}$	-14.3976†	-0.7959‡	14.7425†	1.0803‡	-1.3343	-0.1702	1.3679	0.2669
	5.8828	0.4716	5.897	0.6163	1.7117	0.1345	1.7121	0.3342
$GBC_{i,t-1}$	35.2371	2.4672	-34.9179	-3.1481	-16.0142	-1.3962‡	16.7739	4.8277
	24.2457	2.1108	24.1828	2.5357	10.5925	0.7677	10.8459	3.2438
$GBC_{i,t-1} * BC_{i,t-1}$	-158.2528	1.5896	166.7017	-1.5162	40.2724	-0.5221	-15.9842	-6.4322
	490.7638	33.8932	493.8831	61.0923	144.746	11.0161	144.2406	26.2125
N	938754	886101	938754	861742	353777	290771	353777	275676

Table 7 (cont.): Robustness

Panel I: Alternative filters

	Baxter-King filter All countries				Christiano-Fitzgerald filter All countries			
	Overhang		Applied tariff		Overhang		Applied tariff	
	FE OLS	FE PPML	FE OLS	FE PPML	FE OLS	FE PPML	FE OLS	FE PPML
$BC_{i,t-1}$	-10.9522†	-0.6637‡	11.2418†	1.0190‡	-9.5690‡	-0.5693‡	9.8449‡	0.9121‡
	4.7932	0.3849	4.8027	0.529	5.2915	0.3445	5.3047	0.4704
N	1292811	1177210	1292811	1137904	1292811	1177210	1292811	1137904

Notes: All specifications include market power, PTA import share and log real per capita GDP as controls and include year and country-HS4 fixed effects. All specifications use the same standard errors as Table 2 (OLS) and Table 3 (PPML). All specifications use the same sample as Table 2 except panel D which extends the sample period through 2011, panel C which includes zero tariff bindings and panel G which includes unbound tariffs.
F-test p-value is the p-value from the F-test for joint significnance of the $BC_{i,t-1}$ coefficient plus the interaction coefficient.
‡ p<0.10, † p<0.05, * p<0.01

Table A1: Countries in our dataset

<u>Developed (16)</u>
All tariff years and all GDP years (8)
Australia, Canada, European Union, Israel, Japan, Norway, Singapore, United States

Only missing GDP years (6)
Brunei (1960-1973), Hong Kong (1960-1964), Macao (1960-1981), New Zealand (1960-1976), Switzerland (1960-1979), Saudi Arabia (1960-1968; joined WTO 12/11/2005)

Only missing tariff years (1)
Iceland (2002)

Missing GDP years and tariff years (1)
Qatar (1960-1969; 2000-2001)

<u>Developing (51)</u>
All tariff years and all GDP years (23)
Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Guatemala, Honduras, Indonesia, Madagascar Malaysia, Mexico, Nicaragua, Papua New Guinea, Paraguay, Peru, Philippines, South Africa, Togo, Turkey, Venezuela, China (joined WTO 12/11/2001), Panama (joined WTO 9/6/1997)

Only missing GDP years (10)
Cuba (1960-1969, 2013), Egypt (1960-1964), El Salvador (1960-1964),
Macedonia FYR (1960-1989; joined WTO 4/4/2003), Mongolia (1960-1980; joined WTO 1/29/1997),
Albania (1960-1979; joined WTO 9/8/2000), Georgia (1960-1964, joined WTO 6/14/2000),
Jordan (1960-1974, joined WTO 4/11/2000), Ecuador (1960-1964; joined WTO 1/21/1996),
Nepal (1960; joined WTO 4/23/2004)

Only missing tariff years (14)
Bangladesh (2001), Cameroon (2000), Central African Republic (2000), Cote d'Ivoire (2000), Gabon (2006), Ghana (2005-2006), Guyana (2004-2005), India (2003), Kenya (2003), Niger (2000) Senegal (2000), Sri Lanka (2002), Uruguay (2003), Zambia (2000)

Missing GDP and tariff years (4)
Mali (1960-1967; 2000-01), Mauritius (1960-1976; 2003), Tunisia (1960-1965; 2001, 2007) Thailand (1960-1964; 2002)

<u>Developed and developing (5)</u>
Antigua & Barbuda (developing 2000-2001, 2003-2004, 2009; developed 2002,2005-2008; missing tariff years 1960-1975)
Bahrain (developing 2000; developed 2001-2009; missing GDP years 1960-1979)
Korea (developing 2000; developed 2001-2009)
Oman (developing 2000-2006; developed 2007-2009; joined WTO 11/9/2000)
Trinidad & Tobago (developing 2001-2005; developed 2006-2008; missing tariff years 2000, 2009)

Notes: Unless otherwise noted, years in parenthesis indicate missing years. Level of development source: http://siteresources.worldbank.org/DATASTATISTICS/Resources/OGHIST.xls
with developed = high-income and developing = not high-income. New WTO member definition based on Beshkar et. al. (2014) with new members included in our regressions in their first full year of WTO membership. All tariff years = 2000-2009 and all GDP years = 1960-2013.

Table A2: Variable definitions and sources

Variable	Description	Source
Tariff variables		
$\tau_{i,j,t}$	Applied tariff of country i on product j in year t	WTO Integrated Database and UNCTAD TRAINS database (http://wits.worldbank.org/)
$\bar{\tau}_{i,j,t}$	Tariff binding of country i on product j in year t	WTO Integrated Database (http://wits.worldbank.org/) and new member accession schedules (http://www.wto.org/english/tratop_e/schedules_e/goods_schedules_table_e.htm)
$v_{i,j,t}$	Tariff binding less applied tariff for country i on product j in year t	
Covariates		
$BC_{i,t-1}$	Cyclical component in year t-1 of country i's log real GDP using Hodrick Prescott filter with real GDP measured in local currency units	World Bank's World Development Indicators (http://data.worldbank.org/data-catalog/world-development-indicators); UN National Accounts Main Aggregates Database (http://unstats.un.org/unsd/snaama/introduction.asp); Penn World Tables (https://pwt.sas.upenn.edu/)
$y_{i,t}$	Log per capital real GDP measured in 2005 US$	
$MP_{i,j}$	Natural log of $1/e_{i,j}$ where $e_{i,j}$ is the export supply elasticity of product j from the perspective of the importer i	Nicita et. al (2013)
$PTA\_IM_{i,j,t}$	Weighted share of country i's imports of product j in year t sourced from countries who are FTA or CU partners of country i. The (time-invariant) weights use import shares in product j from a year prior to country i appearing in sample.	COMTRADE (http://wits.worldbank.org/); NSF-Kellogg Institute Data Base on Economic Integration Agreements (http://kellogg.nd.edu/faculty/fellows/bergstrand.shtml)
$Intermed_j$	= 1 if product j is an intermediate product and = 0 otherwise	http://www.macalester.edu/research/economics/PAGE/HAVEMAN/Trade.Resources/TradeData.html
$TTB_{i,j,t}$	= 1 if product j is under a TTB in country i and year t and = 0 otherwise	Bown (2010)
$GBC_{i,t-1}$	Trade weighted average of $BC_{k,t-1}$ in countries other than country i. The time-invariant weights are import shares for the same year as the time-invariant weights for $PTA\_IM_{i,j,t}$	Same as for $BC_{i,t-1}$; COMTRADE (http://wits.worldbank.org/)
$\Delta IM_{i,j,t-1}$	Change in country i imports of product j between years t-1 and t-2 (measured in 000's million 2010 USD)	COMTRADE (http://wits.worldbank.org/); http://data.worldbank.org/indicator/FP.CPI.TOTL
$\Delta IM^{Share}_{i,j,t-1}$	Change in country i's share of world imports of product j between years t-1 and t-2	
$sd\Delta IM_{i,j,t-1}$	Standard deviation of $\Delta IM_{i,j,t-1}$ over the sample period	
$sd\Delta IM^{Share}_{i,j,t-1}$	Standard deviation of $\Delta IM^{Share}_{i,j,t-1}$ over the sample period	
Instruments		
η^{IM}_j	Global average of product j import demand elasticity	Nicita et. al. (2013)
η^{EX}_j	Global average of product j export supply elasticity from perspective of exporter	
Other		
$Unbound_{i.j}$	= 1 if country i has no tariff binding on product j in yeat t and = 0 otherwise	WTO Integrated Database (http://wits.worldbank.org/)
Zero tariff binding	= 1 if country i's tariff binding on product j in yeat t is zero and = 0 otherwise	

Table A3: Summary statistics

	All countries				
	N	Mean	St. Dev.	Min.	Max.
Tariff variables					
$\tau_{i,j,t}$	1806370	7.900	13.558	0	3000
$\bar{\tau}_{i,j,t}$	1481302	22.963	22.775	0	3000
$v_{i,j,t}$	1476664	15.351	16.803	0	1485
Covariates					
$BC_{i,t-1}$	1811008	0.0016	0.019	-0.135	0.0885
$y_{i,t}$	1811008	8.624	1.424	5.518	11.12
$MP_{i,j}$	1811008	-2.765	3.043	-11.401	21.72
$PTA\_IM_{i,j,t}$	1811008	0.180	0.295	0	1
$Intermed_j$	1773073	0.557	0.497	0	1
$TTB_{i,j,t}$	1811008	0.011	0.103	0	1
$GBC_{i,t-1}$	1811008	0.0032	0.011	-0.051	0.03
$\Delta IM_{i,j,t-1}$	1616713	0.0231	0.93142	-184.63	350.346
$sd\Delta IM_{i,j,t-1}$	1728724	0.0743	0.82032	0	159.555
$\Delta IM_{i,j,t-1}^{Share}$	1614768	3E-05	0.01676	-0.9925	0.91385
$sd\Delta IM_{i,j,t-1}^{Share}$	1728333	0.0059	0.0164	0	0.85442
Instruments					
η_j^{IM}	1229544	1.565	2.206	0	28.91
η_j^{EX}	1284235	36.552	169.61	0.442	6800.29
Other					
$Unbound_{i.j}$	1811008	0.182	0.386	0	1
Zero tariff binding	1811008	0.102	0.302	0	1

	Developing					Developed				
	N	Mean	St. Dev.	Min.	Max.	N	Mean	St. Dev.	Min.	Max.
Tariff variables										
$\tau_{i,j,t}$	1217020	10.136	14.729	0	3000	589350	3.281	9.153	0	800
$\bar{\tau}_{i,j,t}$	969715	29.644	22.472	0	3000	511587	10.300	17.311	0	800
$v_{i,j,t}$	966334	19.921	16.965	0	1485	510330	6.698	12.554	0	340
Covariates										
$BC_{i,t-1}$	1220401	0.0010	0.020	-0.135	0.0844	590607	0.0027	0.018	-0.064	0.0885
$y_{i,t}$	1220401	7.795	0.908	5.518	9.83	590607	10.335	0.404	9.262	11.12
$MP_{i,j}$	1220401	-3.216	2.507	-11.401	20.73	590607	-1.832	3.758	-11.043	21.72
$PTA\_IM_{i,j,t}$	1220401	0.178	0.298	0	1	590607	0.186	0.288	0	1
$Intermed_j$	1195781	0.568	0.495	0	1	577292	0.537	0.499	0	1
$TTB_{i,j,t}$	1220401	0.010	0.099	0	1	590607	0.012	0.111	0	1
$GBC_{i,t-1}$	1220401	0.0031	0.012	-0.051	0.03	590607	0.0033	0.010	-0.015	0.02
$\Delta IM_{i,j,t-1}$	1086244	0.013	0.564	-47.147	252.63	530469	0.0438	1.41128	-184.63	350.3455
$sd\Delta IM_{i,j,t-1}$	1163325	0.041	0.414	0	84.11	565399	0.14371	1.3028	0	159.5553
$\Delta IM_{i,j,t-1}^{Share}$	1084777	0.0002	0.013	-0.993	0.87	529991	-0.00028	0.02274	-0.9281	0.913845
$sd\Delta IM_{i,j,t-1}^{Share}$	1163072	0.004	0.013	0	0.53	565261	0.01004	0.02151	0	0.854423
Instruments										
η_j^{IM}	795939	1.583	2.200	0.017	28.91	433605	1.531	2.216	0	28.90
η_j^{EX}	839509	32.615	137.14	0.442	6800.29	444726	43.984	217.91	0.442	6800.29
Other										
$Unbound_{i.j}$	1220401	0.205	0.404	0	1	590607	0.134	0.340	0	1
Zero tariff binding	1220401	0.022	0.148	0	1	590607	0.266	0.442	0	1

Notes: See Table A2 for a description of the variables and their source.