# Could tariffs be pro-cyclical?

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**Abstract**

Conventional wisdom says tariffs are counter-cyclical. We analyze 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. Further investigation reveals this pro-cylicality is driven by the tariff setting behavior of developing countries; tariffs are acyclical in developed countries. We present evidence that pro-cyclical market power drives the pro-cyclicality of tariffs in developing countries, providing further evidence of the importance of terms of trade motivations in explaining trade policy.

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# 1 Introduction

Conventional wisdom echoes 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 (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 policy makers favoring the interests of import-competing sectors over the interests of other sectors. Indeed, because of this inherent problem, 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 empirical literature questioning the counter-cyclicality of applied tariffs. We build a product-level dataset covering more than 5000 products and 72 developing and developed countries over the years 2000 to 2011. Completely counter to the conventional wisdom that applied tariffs are counter-cyclical, we find that applied tariffs are actually pro-cyclical. Indeed, our results suggest that fluctuations related to the business cycle represent about 11% of the average applied tariff change and thus indicate a non-trivial, but modest, 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 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 excluding the Great Recession years from our sample.

To investigate the driving force behind our result that tariffs are pro-cyclical, we first split the sample into developed and developing countries. Importantly, we find that the pro-cyclicality of applied tariffs in the overall sample is driven by developing countries. In contrast, applied tariffs in developed countries are acyclical.

We then explore the possibility that terms of trade motivations are driving the pro-cyclicality of applied tariffs in developing countries. Terms of trade motivations imply that a country with higher market power sets a higher optimal tariff, equal to the inverse elasticity of export supply, to improve its own terms of trade. One simple mechanism consistent with pro-cyclical tariffs in this context is pro-cyclical market power: pro-cyclical import demand shifts the import demand curve up onto a more inelastic part of the export supply curve during booms and, in turn, the importer has more market power and a higher optimal tariff.

We investigate two observable implications to determine whether pro-cyclical tariffs could indeed be driven by terms of trade motives via a pro-cyclical market power mechanism. First, to the extent that cross-country variation in product-level market power is large relative to temporal variation in market power at the country-product level, we expect to observe pro-cyclical tariffs only for country-product pairs that have a high measure of time invariant market power. Using the Nicita et al. (2013) estimations of time invariant market power, we find strong evidence consistent with this expectation.[1] Tariffs are indeed pro-cyclical in developing countries only for country-product pairs with high values of the Nicita et al. (2013) time invariant market power measure.

Second, theoretically, an importer's market power is proportional to its share of world imports. If terms of trade motives are driving pro-cyclical tariffs, then we expect to find temporal applied tariff fluctuations only in the presence of temporal fluctuations in an importer's share of world imports. When developing countries have high market power for a given product, we find strong evidence of this link between world import share and applied tariffs.

Finally, we investigate a possible interpretation based on an empirical implication of Bagwell and Staiger (1990) as identified by Bown and Crowley (2013b). Theoretically, Bagwell and Staiger (1990) show that temporary increases of applied tariffs can neutralize an importer's incentive to exploit terms of trade motivations, and thus prevent a tariff war, when idiosyncratic shocks increase the incentive to act on terms of trade motivations. Bown and Crowley (2013b) observe that a key empirical implication is one should only expect to see fluctuations in an importer's tariff when *both* (i) imports are fluctuating and (ii) the product of the inverse export supply elasticity faced by an importer and the importer's own inverse import demand elasticity is sufficiently high. That is, a country will impose higher

[1] Nicita et al. (2013) have estimated the elasticity of export supply from the perspective of the importer at the HS6 product level for over 100 importing countries.

tariffs only if market power is sufficient to activate the terms of trade motivation but the efficiency costs of imposing the tariff are not too high. We find strong evidence in the data that the pro-cyclical tariff result in developing countries only emerges when both criteria are satisfied. The result is thus consistent with the theory that pro-cyclical imports require temporary tariff increases in order to alleviate terms of trade pressures and prevent a tariff war.

In exploring pro-cyclical tariffs and their links to terms of trade motives, our paper relates to the distinct literatures that explore the cyclicality of trade policy and the role played by terms of trade theory in explaining trade policy. It is closely related to Gawande et al. (2011) and Rose (2013), both of which find applied tariff protection to be acyclical.[2,3] Gawande et al. (2011) focus on 7 developing countries and analyze the factors influencing how product-level (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 effect of additional lobbying for higher tariffs 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 resembles 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 resembles Rose (2013) because our panel dataset spans many years (although the time span is shorter than that in Rose) and a broad range of countries, but differs because we use disaggregated product-level data.[4] Indeed, to our knowledge, ours is the first paper to

[2] An older literature analyzes the cyclicality of protectionism using pre-World War II, and therefore pre-GATT and pre-WTO, 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 find counter-cyclicality while those with data spanning the war have less consistent findings.

[3] Interestingly, although they do not emphasize this, the results of Bohara and Kaempfer (1991b) indicate a pro-cyclical relationship between real GNP and applied tariffs. Rather, the point of their paper is that macroeconomic variables Granger cause tariffs but not vice-versa.

[4] Kee et al. (2013) compute the "overall trade restrictiveness index" (OTRI) for over 100 countries in 2008 and 2009. The index is a country level "average tariff" that aggregates bilateral applied tariffs and bilateral 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,

analyze the cyclicality of applied tariffs after formation of the WTO using a broad range of countries and disaggregated tariff data. Indeed, when we perform aggregate regressions similar to those performed by Rose, we find no robust evidence that tariffs are cyclical which is consistent with Rose's results using aggregate data. Thus, our results suggest that using disaggregated tariff data can reveal cyclical patterns clouded by aggregation.

In contrast to both this paper and the aforementioned recent studies emphasizing that applied tariffs are not counter-cyclical, others (see Knetter and Prusa (2003), Bown and Crowley (2013a) and Bown and Crowley (2014)) find that temporary trade barriers are counter-cyclical.[5] This suggests that different mechanisms underlie the cyclicality of temporary trade barriers and applied tariffs. Given our evidence that applied tariff pro-cyclicality is driven by pro-cyclical market power, one possible explanation is that the conventional wisdom of policy makers responding to the cyclical preferences of import-competing interests is more important for temporary trade barriers than applied tariffs. This seems reasonable since the institutional context of temporary trade barriers is designed to respond to the needs of individual import-competing interests while the context of applied tariff setting accommodates opposing interests of multiple industries both inside and outside the import-competing sector.

Our paper also contributes to the recent literature emphasizing the role played by terms of trade theory in explaining trade policy. This theory asserts that (i) countries exploit their market power (as measured by the inverse export supply elasticity) to improve their terms of trade when setting tariffs and (ii) the purpose of cooperative trade agreements is internalizing the resulting negative terms of trade externalities.

The empirical literature has taken various approaches to investigating the role played by the terms of trade theory given that cooperative WTO trade agreements should actually eliminate the imprint of market power on negotiated tariffs. Broda et al. (2008) find that market power influences unilateral tariff setting of *non*-WTO members. Bagwell and Staiger (2011) show that negotiated tariff binding schedules of countries acceding to the WTO exhibit larger *concessions* when the importer had larger market power. Ludema and Mayda (2013) show that the imprint of market power on an importer's applied tariff is stronger when a larger share of world imports originate from exporters who *did not* participate in tariff negotiations. Bown and Crowley (2013b) focus on U.S. temporary trade barriers (TTBs),

they conclude that any increase can explain only a very small part of the 2009 global trade collapse.

[5] 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.

whose tariffs are *not* cooperatively negotiated, and show the U.S. is more likely to implement a product-level TTB in years where it has stronger terms of trade motivations.[6]

A recent alternative approach to investigating the role of market power has been adopted in papers that investigate the relationship between market power and binding overhang (i.e. the difference between negotiated tariff bindings and applied tariffs). In the presence of privately observed political shocks, which create a demand for tariff flexibility via binding overhang, Beshkar et al. (2015) show that an optimal agreement assigns lower tariff bindings to countries with higher market power to minimize the magnitude of realized terms of trade externalities. In turn, as Beshkar et al. (2015) empirically verify, binding overhang will be lower on products where countries have high market power. Nicita et al. (2013) show that, empirically, applied tariffs appear cooperative (i.e. negatively related to market power) when binding overhang is low but non-cooperative (i.e. positively related to market power) when binding overhang is high.

We contribute to the literature emphasizing the role played by the terms of trade in tariff policy by showing that time varying market power appears to drive the pro-cyclical applied tariff behavior that we observe in developing countries. The fact that we only find tariff cyclicality in developing countries is perhaps not surprising given that (i) developing countries have significantly higher binding overhang than developed countries, which provides substantial flexibility in setting applied tariffs and (ii) as documented by Nicita et al. (2013), many developing countries did not negotiate their tariff bindings during the Uruguay round but rather submitted their tariff binding schedules after the conclusion of the Uruguay round negotiations.

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 main empirical results. Section 5 investigates numerous robustness specifications. Section 6 explores the links between applied tariff fluctuations and terms of trade motivations. The final section concludes.

# 2 Empirical models

Attempting to estimate the cyclicality of tariffs creates a number of issues regarding the estimation technique. Thus, we use two estimation techniques with all specifications using product-level (i.e. 6 digit HS6) tariffs.

[6] Nevertheless, Oatley (2015) finds that the real growth rate is positively correlated with, but not a statistically significant determinant of, the annual number of US anti dumping petitions stretching back to the 1960s.

Our simplest estimation uses fixed effects OLS. Here, we estimate

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

where $\tau_{i,j,t}$ denotes the MFN applied tariff for product $j$ in country $i$ and year $t$. $BC_{i,t-1}$ is a lagged measure of the business cycle in country $i$, so $\theta$ 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, $\mathbf{x}_{i,j,t} = [MP_{i,j}, PTA\_IM_{i,j,t}, y_{i,t-1}]$ where $MP_{i,j}$ is a measure of market power for importing country $i$ in the market for product $j$, $PTA\_IM_{i,j,t}$ is the share of country $i$'s imports of product $j$ in year $t$ sourced from preferential trade agreement (PTA) partners, and $y_{i,t-1}$ is country $i$'s lagged trend of log real GDP.[7] In Section 5.1, 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), Bown and Crowley (2013b), Ludema and Mayda (2013), Nicita et al. (2013) and Beshkar et al. (2015)). We follow Nicita et al. (2013) and Beshkar et al. (2015) 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. (2015), 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 tariff access they receive relative to non-PTA partners (also see, e.g., Limão (2007)). Any such mechanism should be stronger when the share of imports sourced from PTA partners is higher. 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, we also control for the lagged trend in log real GDP of country $i$, $y_{i,t-1}$, as tariff levels may be systematically correlated with development levels. Given the natural trend present in $y_{i,t-1}$, controlling for $y_{i,t-1}$ also helps control for the downward trend in tariffs over time.

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 $\gamma_t$ and importer-sector fixed effects $\gamma_{i,HS4}$. Year fixed effects $\gamma_t$ help control for any time-

[7] Note that, by construction, $BC_{i,t-1} + y_{i,t-1}$ equals country $i$'s log real GDP in year $t-1$. Thus, our business cycle and trend variables can be viewed as a decomposition of log real GDP.

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 a 4-digit HS4 category. These control for any time-invariant characteristics of sectors within countries, including importer-sector specific political economy influences that are time invariant. The use of importer-sector fixed effects implies that our results are driven by variation within these importer-sector clusters and not by cross-sector variation within a country or by cross-country variation within (or across) sectors.

Notice that the key variable of interest, $BC_{i,t-1}$, is measured at the country level which is more aggregated than the dependent variable, $\tau_{i,j,t}$, which is measured at the country-product-year level. 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 its simplicity is certainly appealing, OLS suffers an important drawback for analyzing tariffs: by definition, tariffs must be non-negative. Previous work (e.g. Beshkar et al. (2015)) 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)).[8] 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)).[9] Thus, we also implement PPML estimation in order to deal with the non-negativity constraint on tariffs.

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

[8]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)).

[9]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.

context, this equates to

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

and the assumption that $\mathrm{E}\big(\varepsilon_{i,j,t}|BC_{i,t-1}, \mathbf{x}_{i,j,t}, \gamma_t, \gamma_{i,HS4}\big) = 0$ . This implies that $\mathrm{E}(\tau_{i,j,t}|BC_{i,t-1}, \mathbf{x}_{i,j,t}, \gamma_t, \gamma_{i,HS4}\big) = \exp\big(\theta BC_{i,t-1} + \mathbf{x}_{i,j,t}\beta + \gamma_t + \gamma_{i,HS4}\big)$.

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, despite our large sample size, the conservative standard errors imply the threshold for obtaining statistical significance in the PPML specifications that follow is quite demanding.[10] Because of this and the fact that PPML explicitly recognizes the non-negativity constraint on tariffs, the PPML specifications are our preferred specifications.

# 3 Data

## 3.1 Overview

Our baseline dataset has 2,272,600 country-product year observations for 72 countries countries at the disaggregated product (i.e. 6-digit HS6) level between 2000 and 2011 (see Table A1 in the Appendix). Table A2 in the Appendix summarizes our data and the sources for these data.

Most of our applied tariff data are from the WTO's Integrated Data Base tariff database via WITS (World Integrated Trade Solution) 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 are missing no more than two years of tariff data during our primary years of interest, 2000-2011.[11] All bound tariff data are from the WTO via WITS.

[10] Indeed, the statistical significance of our later results are substantially higher if we use less conservative standard errors that cluster at a more disaggregated level.

[11] For countries that joined the WTO prior to our sample, which begins in 2000, this equates to 10 of the 12 years in our sample. For countries that joined the WTO in or after the first year in our sample, we apply the same rule of allowing only 2 years of missing data to those years in which they were members of the WTO. Later, as a robustness exercise, we exclude all countries who joined the WTO after its creation in 1995.

We set 2000-2011 as our baseline years for two reasons. First, the Uruguay Round, concluded in 1994, led to substantial tariff binding concessions. Thus, we focus on the post-1994 WTO years. Second, in analyzing the cyclicality of tariffs, it is critical that we avoid reaching conclusions based on the institutional necessity of reducing MFN tariffs to meet these new tariff binding obligations. Thus, we exclude the years during which countries were allowed to gradually phase in tariff reductions to meet their tariff binding obligations. Specifically, the phase-in period was 5 years for industrial products in all countries, 6 years for agricultural products in developed countries, and 10 years for agricultural products in developing countries (Hoda (2001, p.66)). Hence, we exclude the years 1995-1999 in their entirety and agricultural products for the additional years.

In addition to the Uruguay Round phase-in periods, we account for two other institutional features relating 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.[12]

Our business cycle and trend GDP variables 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.[13,14] 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 5.1, we analyze robustness of our baseline results to using the Baxter-King and Christiano-Fitzgerald filters.

Until recently, obtaining disaggregated measures of market power at the product level

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

[13] 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.

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

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 their approach 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.[15] 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.[16]

In addition to the variables described above, we augment the dataset with additional control variables for the robustness analysis in Section 5.1 and our investigation of a terms of trade explanation in Section 6. First, we add 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)). Second, we add whether product $j$ is an intermediate good or not based on the UN Broad Economic Categories classification

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

[16] Lack of trade data availability causes us to use trade data from 2000 for Qatar and Bahrain. Nevertheless, there is no tariff data for Qatar in 2000.

system.[17] Third, 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 the sum of all of 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

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

We also add variables related to imports. Specifically, we utilize (i) country $i$'s lagged log real imports of product $j$, $IM_{i,j,t-1}$, and its standard deviation $sdIM_{i,j,t-1}$, (ii) country $i$'s lagged share of product $j$ world imports, $IM^{share}_{i,j,t-1}$, and (iii) country $i$'s lagged detrended (i.e. first differenced) log real imports of product $j$, $\Delta IM_{i,j,t-1}$, and its standard deviation, $sd\Delta IM_{i,j,t-1}$.

As described above, we exclude any observations where a country is still in a phase-in period for a particular product and thus may still be adjusting its MFN tariff to meet its new tariff binding obligation. We also eliminate observations for a country prior to joining the WTO because then it was not constrained by any tariff bindings (see Table A1 for details on new members). We also 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. After these exclusions, we have the total of $2,272,600$ 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 development.[18]

A few points stand out from the summary statistics. Regarding the tariff variables, tariff bindings are significantly greater than MFN applied tariffs, giving countries significant leeway to change their applied tariffs up and down over time: for the overall sample, the mean tariff binding is 22.5% while the mean applied tariff is only 7.9%. While developing countries have both a larger mean tariff binding and mean applied tariff than developed countries (29.2% vs. 10.1% and 10.1% vs. 3.5% respectively), the larger tariff bindings dominate the larger applied tariffs and lead to greater flexibility in tariff setting for developing countries.

There are also some notable differences between developing and developed countries with regard to the covariates. On average, countries are .08% below trend GDP over our sample with a standard deviation of 2.0% points. But, on average, the business cycle is weaker in developing countries (0.1% below trend versus 0.02% below trend). Perhaps surprisingly, the

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

[18] 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).

variation in the business cycle is similar between developing and developed countries (standard deviation is 2.0% for both). Not surprisingly, the trend of log real GDP is significantly greater in developed countries.[19]

## 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 and decrease.[20] Panel A of Table 1 summarizes the frequency of tariff changes in our sample. For 11.38% of observations, the applied tariff changed relative to the prior year, and this is significantly higher in developing than developed countries (13.72% vs. 6.80%). 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 20.44% of such observations are applied tariff increases. 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 4-5% points both for the overall sample and for the subsample of developing countries. Indeed, the average tariff increase is bigger than the average tariff decrease for the overall sample as well as both subsamples.

Figure 1 illustrates the pattern of applied tariff changes over time. Panel A shows a noticeable downward trend in the frequency of applied tariff decreases over time with this number falling from about 19% of all observations in the early 2000s to the 4-5.5% range in the 2008-2011 period. While applied tariff increases accounted for 4.5-5% of observations in the early 2000s, they have remained a steady share of 1-1.5% of observations for 2008-2011. Thus, throughout the sample period, applied tariff increases represent a non-negligible proportion of applied tariff changes.[21]

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 lagged global business cycle that merely

[19] Recall that this is the trend of log real GDP, so the difference is substantial.

[20] 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 rising and falling over time.

[21] 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 than the imposition of new TTBs even amongst many of the most prolific users of TTBs.

averages $BC_{i,t-1}$ across all observations in a given year of our sample. Two noteworthy points emerge. First, 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 Recession.[22] Second, evidence at this level of aggregation does *not* suggest that the direction of tariff changes are systematically related to the average business cycle across countries.[23]

Since aggregation at the national level can conceal much of the product-level variation observed in the data, the empirical analysis in Section 4 focuses on the cyclicality of 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, 57.98% 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 26.62% 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, 11.37% 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 (14.05% vs. 4.88%). Thus, there is a significant number of products where countries move the applied tariff up and down over the sample period.

When thinking about the cyclicality of tariffs, one normally has in mind comparing product level tariffs at different points of the business cycle for a given country. That is, one has in mind a comparison of tariffs *within* a country-product cluster. Panel A of Figure 2 illustrates this comparison graphically by plotting the difference between the applied tariff for a country-product-year ($\tau_{i,j,t}$) and the mean applied tariff for this country-product ($\tilde{\tau}_{i,j} \equiv \frac{1}{10}\sum_{t=2000}^{2011} \tau_{i,j,t}$) against the difference between the lagged business cycle measure for the country ($BC_{i,t-1}$) and the mean business cycle for the country ($\widetilde{BC}_{i,t-1} \equiv \frac{1}{10}\sum_{t=2000}^{2011} BC_{i,t-1}$); the figure also shows the OLS regression line of $\tau_{i,j,t} - \tilde{\tau}_{i,j}$ on $BC_{i,t-1} - \widetilde{BC}_{i,t-1}$. 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

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

[23] This is consistent with the results in Rose (2013) who analyzes cyclicality of tariffs aggregated at the national level and finds an acyclical relationship.

country-product clusters where the applied tariff changed from the previous year. For products with varying applied tariffs, the figure thus shows how temporal fluctuations in country $i$'s tariff on a given product $j$ correlate with temporal fluctuations in country $i$'s business cycle. 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 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 .060 with a standard deviation of .037. The slope of 26.5 then implies a difference of about 1.59% 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 3-4.5% points, this difference of 1.59% points induced by the business cycle represents about 35-53% 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.[24] 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 Pro-cyclical applied tariffs

Panel A of Table 2 presents the results from OLS estimation of equation (1). Column (1) includes only the business cycle variable ($BC_{i,t-1}$) and excludes fixed effects. Columns (2) and (3), respectively, add country-HS4 and year fixed effects. Columns (4), (5) and (6) in turn add the lagged trend of log real GDP ($y_{i,t-1}$), market power ($MP_{i,j}$), and PTA import share ($PTA\_IM_{i,j,t}$) as respective covariates. Column (7) instruments for market power. For comparison, column (8) performs the OLS estimation of column (6) but only using the observations from column (7).

The pro-cyclicality of tariffs emerges in columns (4)-(8) once the lagged trend of log real GDP is included; the point estimate is positive, statistically significant at the 10% level, and very stable across these specifications. Comparing columns (7) and (8), the IV estimates do not significantly affect either the economic or statistical significance of the estimated business

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

cycle coefficient, although the restricted sample does marginally increase the magnitude of the coefficient. Interestingly, introducing market power does not affect either the magnitude or the economic significance of the business cycle coefficient.

In addition to the sign and statistical significance of the coefficient estimate on $BC_{i,t-1}$, the economic magnitude of the cyclicality is also of interest. The average gap between a country's maximum and minimum value of $BC_{i,t-1}$ over our sample period is 0.060, while the gap is 0.097 for a country that is 1 standard deviation above the mean. These numbers provide measures of the magnitude of business cycle fluctuations and one could, intuitively, think of 0.060 as a proxy for the average fluctuation between the peak of the boom and the trough of the recession. The point estimate of 7.44 for the coefficient on $BC_{i,t-1}$ then implies that the fluctuation in applied tariffs between the peak of the boom and the trough of the recession is about 0.45% points and represents about 11.2% of the average magnitude of applied tariff changes.[25] For a country with business cycle fluctuations 1 standard deviation above the mean, this becomes about 18.0% 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 negative coefficients on the lagged trend of log real GDP in columns (6)-(8) demonstrate the expected downward trend in tariffs over time as the trend of log real GDP continues rising.[26] 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. (2015)), the estimates in Table 2 suggest that market power is not a statistically significant determinant of applied tariffs. Note that we are using country-HS4 fixed effects and our measure of market power, $MP_{i,j}$, 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 tariffs for HS6 products differ from the country's average tariff across time and products within the HS4 sector. This differs from prior work (e.g. Bagwell and Staiger (2011), Ludema and Mayda (2013), Beshkar et al. (2015)) that relies on differences in market power across HS6 products within broader two-digit HS2 industries. Finally, while the share of imports from PTA partners is positive as expected given the motivation in Section 2, it is not statistically significant.

Prior literature has treated market power as endogenous (e.g. Nicita et al. (2013) and Beshkar et al. (2015)). However, any such endogeneity is unlikely to cause problems in terms

[25] The average magnitude of applied tariff changes is 4.02% points.

[26] Recall that this variable is the trend component of GDP. Thus the negative coefficient says that a higher level of GDP is associated with a lower level of tariffs.

of estimating the cyclicality of overhang because columns (5) and (6) 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. (2015), we instrument for a country's product-level market power using the average product-level import demand elasticity in the rest of the world and the product-level global average export supply elasticity from the view of the exporter. These instruments appear to do reasonably 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 .011). However, the Kleibergen-Paap rk Wald $F$-statistic of 4.65 suggests the instruments are somewhat weak. Nevertheless, we cannot reject the null that the instruments are exogenous based on Hansen's $J$ test of overidentification ($p$-value of 0.087). Moreover, 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 essentially uncorrelated with our regressor of interest and we cannot reject the null that it is indeed exogenous, we henceforth treat market power as exogenous on efficiency grounds.[27] In any case, the sign and statistical significance of the coefficients are preserved with instrumentation.

As discussed in Section 2, OLS assumes the dependent variable can take positive and negative values which ignores the non-negativity constraint imposed on tariffs. Panel B of Table 2 directly addresses this concern by using PPML estimation (see estimating equation (2)), with each column having the same interpretation as the analogous column of Panel A.

Importantly, Panel B shows that the pro-cyclicality of applied tariffs observed under OLS is not driven by the inability of OLS to recognize the non-negativity constraint on tariffs. Specifically, columns (3)-(6) show that the pro-cyclicality of tariffs is preserved under PPML estimation.

The magnitude of tariff pro-cyclicality given by the PPML estimates is similar to that from the OLS estimates. The business cycle point estimate of .867 in column (6) says that the average business cycle fluctuation of 0.060 is associated with a 5.4% rise in the applied MFN tariff.[28] Thus, at the mean tariff of 7.88% points, this average business cycle fluctuation would be associated with a tariff increase of 0.42% points, which is slightly lower than the OLS estimate of 0.45% points. 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 important.

[27] Specifically, omitting an endogenous regressor that is uncorrelated with the key regressor of interest does not bias the estimate of the key regressor.

[28] Specifically, $.054 = \exp(.867 \times .06) - 1$.

In terms of the other covariates, the PPML results tell a similar story to the OLS results. Like the OLS results, temporal fluctuations in tariffs are not systematically related to either market power or the share of imports sourced from PTA partners. Interestingly, the lagged trend of log real GDP is still negatively correlated with tariffs but is no longer statistically significant, although this may be due to our use of more conservative standard errors under PPML (see discussion in Section 2).

Table 3 analyzes the robustness of our pro-cyclical tariff result by varying the sample used under OLS (Panel A) and PPML (Panel B). Column (1) excludes agricultural goods. To address the issue that some HS6 codes are actually an average of more disaggregated HS8 or HS10 tariff lines, column (2) excludes HS6 products that have more than one tariff line within the HS6 code. Columns (3) and (4) each exclude some of the countries in the sample: column (3) excludes countries that joined the WTO after 1995 to ensure that the results are not driven by new WTO members and column (4) excludes China and the EU.[29] Our pro-cyclical tariff result is robust to these four exclusions. Of particular note are the results in column (3). Excluding new WTO members substantially increases the point estimates relating to tariff cyclicality. Intuitively, this is perhaps not surprising because, on average, new WTO members have lower tariff bindings than original WTO members (14.48% vs. 23.74%) which implies they have much less room to vary their applied tariffs.

To address the issue of business cycle outliers, column (5) excludes observations that lie in the top or bottom 1% of our sample distribution for $BC_{i,t-1}$. Importantly, the point estimate on our business cycle variable is very stable relative to the baseline specification that does not exclude business cycle outliers. Thus, our pro-cyclical tariff result is not driven by the most extreme business cycle fluctuations. However, our estimates are less precise when excluding the business cycle outliers and fail statistical significance at the 10% level.

Column (6) excludes two groups of observations. The first group are observations where the applied tariff exceeds the tariff binding as well as subsequent observations where the applied tariff is brought back below the tariff binding. The second group are observations with no tariff binding, a zero tariff binding, or a time varying tariff binding.[30] The results are robust to these exclusions.

Finally, to address any possible structural changes in policies resulting from the Great

[29] 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.

[30] We exclude the first set 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. Exclusion of unbound tariff lines is partly motivated by recent empirical and theoretical work including Handley and Limão (2012), Groppo and Piermartini (2014) and Handley (2014). Furthermore, products with a zero tariff binding have no possibility of tariff fluctuation.

Recession, column (7) excludes the Great Recession years (tariff observations in 2010 and 2011 and thus GDP observations for 2009 and 2010). The OLS and PPML point estimates are both substantially higher than the baseline sample that includes the Great Recession years which suggests the Great Recession years actually mitigated the extent of applied tariff pro-cyclicality.

### 4.2 Cyclicality and level of development

As discussed in Section 3.1, developing countries enjoy significantly higher tariff bindings and binding 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 binding. We therefore investigate whether the cyclicality of 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 4 presents the results and suggests that the cyclicality discussed in Section 4.1 is driven by developing countries. The business cycle point estimates for developing countries in Panel A of Table 4 are larger than the pooled estimates in Table 2 by about 45% for the OLS estimate but only by 10% for the PPML estimate. For developed countries, the point estimates in Panel A of Table 4 suggest counter-cyclical tariffs, but the effects are small in economic magnitude and never close to conventional levels of statistical significance. That is, applied tariffs appear acyclical in developed countries. Thus, the tariff behavior of developing countries drives our pro-cyclical tariff result reported in Table 2. Panels B through D of Table 4 show this is also true for the alternative samples of Table 3.

With a couple of exceptions, the coefficient estimates for the other variables are similar to the baseline results for the pooled sample. The exceptions are that the point estimate for trend log real GDP and the PTA import share is positive and statistically significant for developed countries in one of the two specifications.

## 5 Extensions

### 5.1 Sensitivity analysis

We now include additional control variables to further investigate the robustness of our results in Section 4. Specifically, we consider whether our results are robust to controlling for import surges, the global business cycle, whether a good is an intermediate good, and whether a good is subject to a temporary trade barrier. Finally, we use alternative filtering techniques to measure the business cycle. Table 5 presents the results but, for brevity, only displays the business cycle variable and the added control variable(s). The results indicate that the pro-cyclicality of applied tariffs for developing countries is robust to these sensitivity analyses.

**Import surges.** Recently, the empirical literature has documented the importance of import surges, and their volatility, as a determinant of tariff setting (e.g. Bown and Crowley (2013b)). It is *a priori* plausible that our pro-cyclical applied tariff results could be driven by pro-cyclical import surges (which would then be correlated with our business cycle variable). Thus, Panel A of Table 6 controls for import surges, $\Delta IM_{i,j,t-1}$, and their volatility, $sd\Delta IM_{i,j,t-1}$ (see Section 3.1) and shows the results from Tables 2-4 persist.[31]

**Global business cycle.** Panel B controls for 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. The point estimates for the business cycle variable change only slightly, and the sign and statistical significance remain as in Tables 2-4. The estimated coefficient on the global business cycle variable is not statistically significant for the pooled sample or for developing countries, but the relationship is positive and statistically significant for developed countries under OLS estimation in column (5). This provides some evidence suggesting that a developed country raises (lowers) tariffs on its trading partners when its major trading partners are experiencing a boom (recession).[32]

**Intermediate goods.** Panel C investigates whether the degree of cyclicality depends on whether a good is an intermediate good.[33] We include a dummy $Intermed_j$, which is equal to 1 if product $j$ is an intermediate good (according to the UN's Broad Economics Categories classification system) and also add the interaction term $Intermed_j \times BC_{i,t-1}$. 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 on intermediate goods than non-intermediate goods. The point estimates of cyclicality for non-intermediate goods in developing countries and in the pooled sample (i.e. $BC_{i,t-1}$) are little changed from the baseline results while the point estimates of cyclicality for intermediate goods (i.e. $BC_{i,t-1} + Intermed_j \times BC_{i,t-1}$) are

[31] Given our empirical specification, one may think we should control for the level of log real imports rather than the change in log real imports. But, given the level of log real imports is trending upward over our sample, one can interpret the change in log real imports as a simple measure of detrended log real imports.

[32] This is counter to the expected results based on the model developed in Bagwell and Staiger (2003), according to which countries will keep tariffs lower during booms because they have more to lose if their trade partners retaliate.

[33] Goods that are not intermediate are either primary or final goods.

smaller in magnitude. The $p$-values for the $F$-tests of joint significance (.074 and .072) reject the null hypothesis that tariffs are acyclical for intermediate goods in developing countries at the 10% significance level. The results for developed countries are consistent with the baseline results that tariffs are acyclical.

**Temporary Trade Barriers (TTBs).** Panel D investigates how our results are affected by recognizing that countries can also impose protection via 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 $TTB_{i,j,t} \times BC_{i,t-1}$. In this specification, $BC_{i,t-1}$ represents the cyclicality when a product is not subject to a TTB. The economic and statistical significance of the cyclicality estimate are unaffected by the inclusion of the TTBs variables. Given that only about 1% of 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. The interaction estimates are of the opposite and similar magnitude to the cyclicality estimates, suggesting that the presence of TTBs almost entirely mitigates the cyclicality of tariffs in developing countries. Indeed, the $F$-tests of joint significance cannot reject that null that the applied tariffs of products subject to TTBs are acyclical. For both developed and developing countries, products under TTB protection also have higher applied tariffs. This suggests countries tend to impose TTBs on products that have high applied tariffs and thus applied tariffs and TTBs could be viewed as complements.

**Alternative measures of the business cycle.** Finally, Panels E and F investigate robustness of the cyclicality results to alternative filtering techniques for computing the business cycle variable. Using the Baxter-King and the Christiano-Fitzgerald filters leave the results for all three samples largely intact. However, OLS estimates of cyclicality for the pooled and developing country samples using the Christiano-Fitzgerald filter are somewhat imprecise, just failing statistical significance at conventional levels for the developing country sample.[34] In any case, overall, the results are robust to different filtering techniques.

## 5.2 Cyclicality and aggregate applied tariffs

A key difference with our empirical approach compared to Rose (2013) is that we use highly disaggregated product-level tariff data (and covariates) while Rose (2013) uses aggregate country-level tariff data (and covariates). This difference could potentially help explain why we find pro-cyclical tariffs yet Rose (2013) finds acyclical tariffs. In order to investigate this possibility, we now estimate the relationship between business cycles and aggregate

[34] The $p$-value for the developing countries sample is .109; the $p$-value for the pooled sample is .175. We implement the Christiano-Fitzgerald filter with a third order symmetric moving average (which is the STATA default for the Baxter-King filter) to ensure it is robust to second order trends.

country-level tariffs.

The results, presented in Table 6, indicate that aggregation can obscure the influence of business cycles on product-level applied tariffs. Columns (1)-(3) in Table 6 present the OLS estimation results for the pooled sample, developing country sample and developed country sample respectively. Columns (3)-(6) do the same for the PPML results. Panels A and B use the simple average MFN tariff and weighted average MFN tariff respectively and control only for the lagged business cycle variable.[35] Panels C and D expand the set of covariates to include country-level analogs to our specification in Section 4.1 (see Table A2 for definitions).

For both the pooled sample and the developing country subsample, the estimated coefficient on the business cycle variable is positive but not statistically significant regardless of the specification or estimation technique. Thus, as in Rose (2013), we cannot reject the null hypothesis of acyclicality based on weighted average tariffs.[36] Moreover, for these two samples, none of the other variables appear significantly correlated with the applied tariff. For the developed country sample, the business cycle variable is positive and statistically significant in columns (3) and (6) of Panel B where the only control variable is the lagged business cycle. However, this statistical significance disappears when the lagged trend of log real GDP and the share of imports from PTA partners are included as controls (although the coefficient remains positive). Thus, overall, we conclude that aggregation significantly alters the predicted relationship between business cycles and applied tariffs. In turn, aggregating tariffs at the national level appears to conceal cyclicality that emerges at the product level, where decision making over trade policy typically takes place.

# 6 A Terms of trade explanation

So far, we have documented that applied MFN tariffs appear pro-cyclical in developing countries and that this result is robust to controlling for numerous variables emphasized in the recent empirical and theoretical literature on tariff setting. We now explore whether terms of trade motivations can explain this result. To begin, we outline the theoretical motivations that guide our subsequent empirical investigation.

[35] Note that Rose (2013) uses the contemporaneous rather than the lagged business cycle variable (although our results in Table 5 are robust to using the contemporaneous business cycle). Due to data limitations, our sample of countries is smaller than that in Rose (2013). We also use fewer years due to institutional changes resulting from the formation of the WTO (see Section 3).

[36] The estimated coefficients on the applied tariff variable in Rose (2013, p.577) are generally negative when only the business cycle variable is included but are not statistically significant. When additional covariates are included, the coefficients vary in sign but remain statistically insignificant.

## 6.1 Theoretical motivations

As is well known, the standard formula for a country's (non-cooperative) optimal tariff when maximizing national welfare is to set the ad-valorem tariff equal to the inverse export supply elasticity (e.g. Feenstra (2003, p.220)). Defining market power as the inverse export supply elasticity, optimal tariffs will then be pro-cyclical if and only if market power is pro-cyclical. Intuitively, this pro-cyclical market power could be driven by pro-cyclical shifts of the import demand curve as it moves onto less elastic parts of the export supply curve during periods of economic growth.

If pro-cyclical tariffs result from the impact of pro-cyclical market power on optimal tariffs, we should observe two relationships in the data. First, to the extent that the variation in market power across country-product pairs is large relative to the temporal variation in market power within country-product pairs, pro-cyclicality should only be present for country-product pairs with relatively high levels of time invariant market power. For countries with little market power, we expect any increased market power conferred by booms is likely insufficient to justify raising tariffs, especially if there are costs to changing tariffs (e.g. administrative costs, as argued by Bown and Crowley (2013b, p.1076)).[37]

Second, Nicita et al. (2013, p.13) show that, theoretically, an importing country's product-level market power is proportional to the importing country's product-level share of world imports. This link implies a relationship between temporal fluctuations in an importer's share of world imports and temporal fluctuations in an importer's tariff. Indeed, if changing tariffs imposes some cost (e.g. administrative costs) then we expect to empirically observe applied tariff fluctuations only for sufficiently large fluctuations in an importer's share of world imports.

An alternative theoretical perspective to the standard static optimal tariff formula discussed above is the repeated game environment of Bagwell and Staiger (1990). In their model, the optimal cooperative tariff balances the tension between a country's myopic incentive to exploit its market power by manipulating its terms of trade and a country's anticipation that doing so will instigate a tariff war. As shown by Bown and Crowley (2013b), the key empirical prediction of the model is that temporal fluctuations in tariffs should be positively related to temporal fluctuations in imports only if a country has sufficiently high market power and tariffs generate sufficiently low efficiency losses. The intuition rests on two ideas. First, import surges strengthen a country's motivation to improve its terms of trade by setting an optimal (non-cooperative) tariff. The only way to prevent this move and the resulting tariff war is to neutralize the increased terms of trade incentive by temporarily raising the

[37] In our empirical analysis, we use the time invariant market power measure estimated by Nicita et al. (2013).

cooperative applied tariff. Second, the benefit of raising a tariff is higher when the efficiency costs imposed by a tariff are smaller and the terms of trade gain from imposing a tariff is larger, which will be the case when, from an importer's view, its own import demand and the export supply it faces are both less elastic.

The Bagwell and Staiger (1990) model thus offers a third implication that we investigate below. To the extent that imports are pro-cyclical, we expect to observe pro-cyclical tariffs only when (i) imports deviate substantially from their usual level and (ii) the importer has sufficiently strong market power and the efficiency costs of tariffs are sufficiently small. This latter condition is equivalent to a sufficiently large product of the inverse export supply elasticity and the inverse import demand elasticity.

## 6.2 Empirical results

Given the theoretical terms of trade motivations outlined above, we investigate three empirical relationships. Before doing so, note that imports are indeed pro-cyclical in our sample. Specifically, regressing detrended log real imports on the business cycle yields a positive coefficient and reveals that the average business cycle fluctuation between the trough of the recession and the peak of the boom explains 21.88% of a standard deviation of detrended log real imports.[38] This correlation is important given our intuition behind exploring a terms of trade argument for our pro-cyclical tariff result is driven by the idea that imports are pro-cylical.

First, we consider the link between tariff cyclicality and the Nicita et al. (2013) measures of time invariant market power. To the extent that the variation in market power across country-product pairs substantially exceeds the temporal variation in market power within a country-product pair, we expect to observe pro-cyclical tariffs only for country-product pairs with high market power. Thus, we use the baseline sample to compute thresholds for the $25^{th}$ and $75^{th}$ percentiles of the market power distribution and label country-product pairs in these upper and lower quartiles as low and high market power observations, respectively. We then compare cyclicality across these quartiles.

Panel A of Table 7 presents the results of this comparison. Columns (2) and (6) of Panel A show that, regardless of the estimation procedure, tariffs are pro-cyclical in developing countries when the time invariant measure of market power is high. The remaining columns, on the other hand, show that tariffs are acyclical for country-product pairs in developing countries with low time invariant market power and, regardless of market power, country-product pairs in developed countries. Thus, Panel A suggests that the pro-cyclicality of

[38] The OLS regression of $\Delta IM_{i,j,t-1}$ on $BC_{i,t-1}$, using the same fixed effects and clustering as in our baseline analysis, yields a point estimate on $BC_{i,t-1}$ of 3.68 which is statistically significant at the 1% level.

tariffs we find in our baseline sample is driven not by all products in developing countries but rather by those country-product pairs that have high values of our time invariant market power measure.

Second, we investigate the link between temporal fluctuations in tariffs and temporal fluctuations in market power as represented by the importer's share of world imports.[39] For those country-product pairs in the top quartile of market power in developing countries, we expect to find temporal tariff fluctuations for a product only when there are sufficiently large fluctuations in the importer's share of world imports for that product.

Letting $IM_{i,j,t}^{share} = \frac{IM_{i,j,t}}{IM_{WORLD,j,t}}$ denote importer $i$'s share of world log real imports in product $j$ and year $t$, we define the fluctuation in world import share, $\tilde{m}_{i,j,t} \equiv IM_{i,j,t-1}^{share} - \frac{1}{T}\sum_{t=2000}^{T=2011} IM_{i,j,t-1}^{share}$, as the lagged deviation of the share of world imports from its "usual" level. Using this measure, we separate the high market power products further into two subsamples. One subsample consists of country-product observations that lie in either the top or bottom tercile of the empirical distribution over $\tilde{m}_{i,j,t}$; these observations are experiencing a substantial temporal deviation in their share of world imports. The second comprises country-product observations that lie in the middle tercile of the distribution of $\tilde{m}_{i,j,t}$, which are experiencing only a minimal temporal deviation in their share of world imports.

Panel B of Table 6 confirms our expectation. Columns (3) and (6) clearly show we cannot reject the null that an importer's tariffs are acyclical when the product is subject to minimal temporal deviations in its share of world imports (i.e. in the middle tercile of the $\tilde{m}_{i,j,t}$ distribution). On the other hand, the point estimates in columns (2) and (5) reveal that the magnitude of pro-cyclicality is between two and three times as large for a country-product pair that is experiencing substantial temporal fluctuations in its share of world imports (i.e. in the top or bottom tercile of the $\tilde{m}_{i,j,t}$ distribution). Moreover, this pro-cyclicality is statistically significant at the 5% level. Thus, tariff pro-cyclicality is evident in the subset of high market power products in developing countries that are experiencing large deviations in their share of world imports relative to their country-product average. In turn, the mechanism behind our pro-cyclical tariff result is consistent with a pro-cyclical market power mechanism via the proportionality of market power and world import share.

The third empirical implication we investigate is identified by Bown and Crowley (2013b) based on the theoretical model of Bagwell and Staiger (1990). According to Bown and Crowley (2013b), we should expect temporal fluctuations in imports to influence tariffs only when the product of the inverse export supply elasticity faced by the importer, $\frac{1}{e_{i,j}}$, and the importer's inverse import demand elasticity, $\frac{1}{e_{i,j}^{m}}$, is sufficiently large. Thus, when

[39] Indeed, Beshkar et al. (2015) use an importer's share of world imports as an alternative measure of market power in addition to the Nicita et al. (2013) measures.

we look within country-product pairs that have high values of $\frac{1}{e_{i,j} \times e^m_{i,j}}$, we only expect to find temporal fluctuations in tariffs when there are substantial fluctuations in imports. To explore this prediction, we use the overall sample to compute the threshold for the $75^{th}$ percentile of the distribution over $\frac{1}{e_{i,j} \times e^m_{i,j}}$ and label observations in the top quartile of the distribution as having high values of $\frac{1}{e_{i,j} \times e^m_{i,j}}$. Also using the overall sample, we now redefine $\tilde{m}_{i,j,t} \equiv IM_{i,j,t-1} - \frac{1}{T}\sum_{t=2000}^{T=2011} IM_{i,j,t-1}$ as the lagged deviation of importer $i$'s product $j$ log real imports in year $t$ from its "usual" level and label observations that lie in either the top or bottom tercile of the empirical distribution over $\tilde{m}_{i,j,t}$ as those experiencing substantial temporal fluctuations in imports.

Panel A of Table 8 presents the results and confirms our expectations (per Bown and Crowley (2013b), we also control for $IM_{i,j,t-1}$ and the volatility of $IM_{i,j,t-1}$). Regardless of the estimation technique, the point estimate is only statistically significant for observations experiencing substantial temporal deviations in imports (columns (2) and (5)) and the point estimate for these observations is roughly twice as large as that for observations experiencing minimal temporal deviations in imports.

A problem with the results presented in Panel A of Table 8 is that real imports are trending upwards over our sample.[40] A simple way to detrend log real imports is to use first differences. To this end, we redefine $\tilde{m}_{i,j,t} \equiv \Delta IM_{i,j,t-1} - \frac{1}{T}\sum_{t=2000}^{T=2011} \Delta IM_{i,j,t-1}$ as the lagged deviation of importer $i$'s product $j$ *detrended* log real imports in year $t$ from its "usual" level. In Panel B of Table 8, we carry out the same analysis as in Panel A but use detrended log real imports. Our results are unchanged and, if anything, are actually stronger. Thus, our pro-cyclical tariff result in developing countries is consistent with an interpretation of the Bagwell and Staiger (1990) model where pro-cyclical imports lead to temporary increases in applied tariffs that prevent tariff wars.

# 7 Conclusion

Conventional wisdom says that applied tariffs are counter-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. While our results are 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.

These results are robust to controlling for numerous variables emphasized in the recent theoretical and empirical literature as important determinants of applied tariffs. Further,

[40] Thus $\tilde{m}_{i,j,t}$ tends to be negative in the early sample years and positive in the later sample years.

we find that the pro-cyclical applied tariff result is driven by the tariff setting behavior of developing countries and that applied tariffs are actually acyclical in developed countries.

We present evidence that terms of trade motivations drive pro-cyclical tariffs in developing countries. Intuitively, this could arise from pro-cyclical imports shifting the import demand curve up onto a more inelastic part of the export supply curve during booms and thereby generating pro-cyclical market power. First using a time invariant measure of market power, we only observe pro-cyclicality for country-product pairs with a high value of this measure. Second, looking within these high market power country-product pairs but using temporal fluctuations in the share of world imports to proxy for time varying market power, we only observe pro-cyclicality in years where country-product market power is unusually high or low. Third, in response to import surges, we observe pro-cyclicality only in country-product-years where both time invariant market power is high and the efficiency costs of tariffs are low, as one would expect based on Bagwell and Staiger (1990) and Bown and Crowley (2013b). Overall, this evidence adds to a growing literature, in both static and dynamic settings, that document the empirical role played by terms of trade motivations in driving trade policy.

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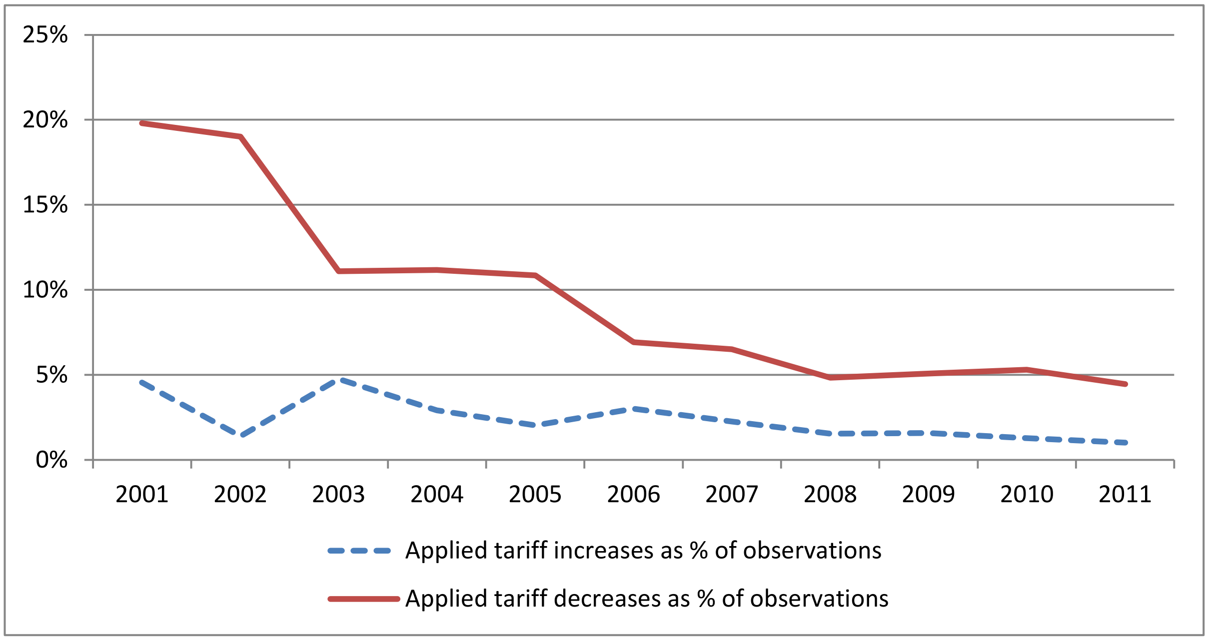
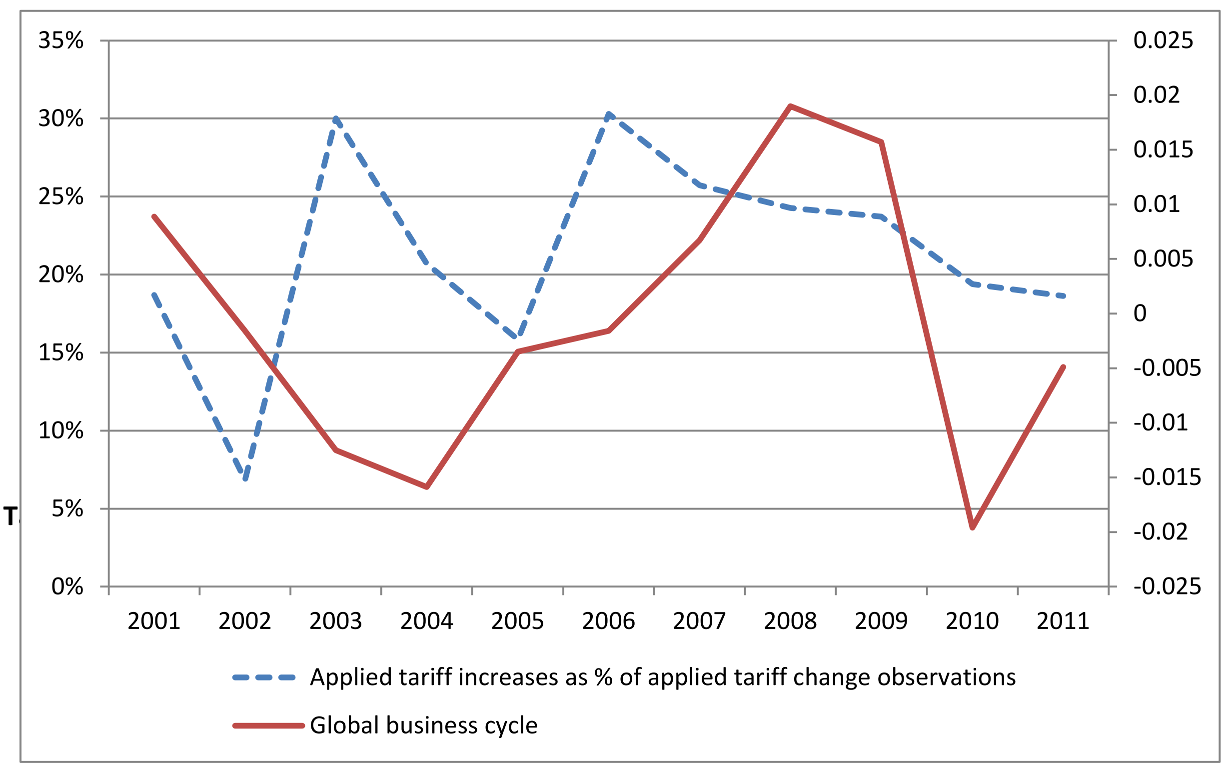
# A Appendix

**Figure 1. Temporal pattern of applied tariff changes**

**Panel A: Temporal pattern of applied tariff increeases and decreases**



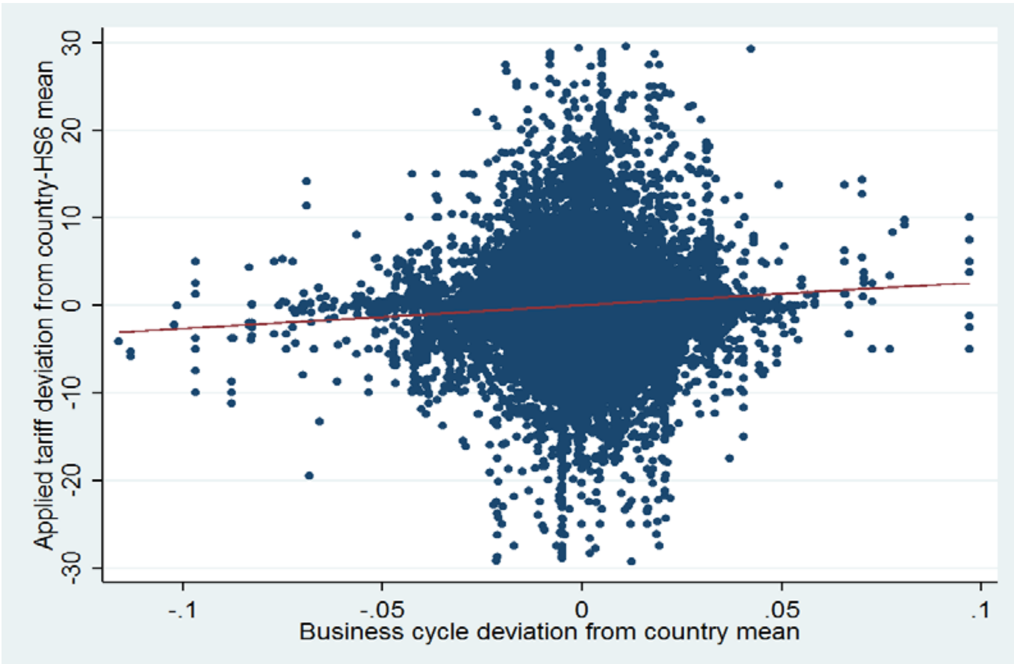

**Panel B: Relationship between tariff increases and global business cycle**



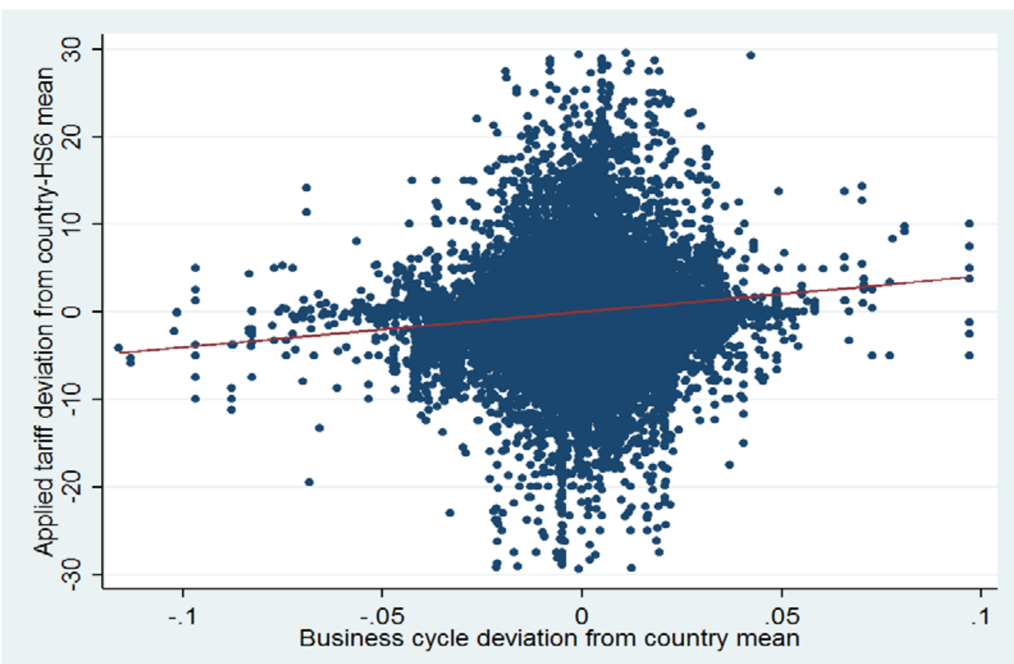

Notes: The sample used is as described in Section 3.1. The global business cycle in panel B is a simple average of the values of $BC_{i,t-1}$ in the sample.

**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. 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 | 1,807,753 | 88.62 | | 1,166,894 | 86.28 | | 640,859 | 93.20 | |
| Changed | 232,218 | 11.38 | -2.16 | 185,495 | 13.72 | -2.44 | 46,723 | 6.80 | -1.03 |
| Total | 2,039,971 | 100 | | 1,352,389 | 100 | | 687,582 | 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 | 184,764 | 9.06 | -3.88 | 147,096 | 10.88 | -4.41 | 37,668 | 5.48 | -1.82 |
| Applied tariff unchanged | 1,807,753 | 88.62 | | 1,166,894 | 86.28 | | 640,859 | 93.20 | |
| Applied tariff increase | 47,454 | 2.33 | 4.55 | 38,399 | 2.84 | 5.10 | 9,055 | 1.32 | 2.23 |
| Total | 2,039,971 | 100 | | 1,352,389 | 100 | | 687,582 | 100 | |

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

| | Pooled | | Developing | | Developed | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| Applied tariff only decreases | 61,231 | 26.62 | 51,660 | 31.72 | 9,571 | 14.26 |
| Applied tariff always unchaged | 133,350 | 57.98 | 82,664 | 50.76 | 50,686 | 75.51 |
| Applied tariff only increases | 9,247 | 4.02 | 5,653 | 3.47 | 3,594 | 5.35 |
| Applied tariff increaases and decreases | 26,151 | 11.37 | 22,875 | 14.05 | 3,276 | 4.88 |
| Total | 229,979 | 100 | 162,852 | 100 | 67,127 | 100 |

Notes: The sample used is that described in Section 3.1.

**Table 2. Cyclicality of tariffs**

**A. Fixed effects OLS**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| $BC_{i,t-1}$ | 7.0585 | 1.318 | 4.9502 | 7.4620‡ | 7.4620‡ | 7.4405‡ | 8.1733‡ | 8.2948‡ |
| | (9.4904) | (3.1019) | (4.0767) | (4.4252) | (4.4252) | (4.4251) | (4.6108) | (4.6115) |
| $y_{i,t-1}$ | | | | -4.1219† | -4.1219† | -4.1334† | -5.7719* | -5.8601* |
| | | | | (1.6584) | (1.6584) | (1.66) | (2.1056) | (2.1053) |
| $MP_{i,j}$ | | | | | 0.0006 | 0.0003 | 0.059 | -0.0052 |
| | | | | | (0.0088) | (0.0088) | (1.1264) | (0.0079) |
| $PTA\_IM_{i,j,t}$ | | | | | | 0.2206‡ | 0.1311 | 0.1209 |
| | | | | | | (0.1321) | (0.2169) | (0.1521) |
| N | 2272600 | 2272520 | 2272520 | 2272520 | 2272520 | 2272520 | 1491953 | 1491953 |
| Country-HS4 FE | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | No | No | Yes | Yes | Yes | Yes | Yes | Yes |
| Underidentification p-value | | | | | | | 0.0113 | |
| Weak instrument rk F stat | | | | | | | 4.6522 | |
| Overidentification p value | | | | | | | 0.0867 | |
| Regressor endogeneity p-value | | | | | | | 0.9534 | |

**B. Fixed effects PPML**

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| $BC_{i,t-1}$ | 0.9031‡ | 0.1693 | 0.6211‡ | 0.8667‡ | 0.8667‡ | 0.8667‡ |
| | (0.5207) | (0.2842) | (0.3756) | (0.4631) | (0.4631) | (0.4628) |
| $y_{i,t-1}$ | | | | -0.5436 | -0.5436 | -0.5436 |
| | | | | (0.4963) | (0.4963) | (0.4962) |
| $MP_{i,j}$ | | | | | 0.0001 | 0.0001 |
| | | | | | (0.0015) | (0.0014) |
| $PTA\_IM_{i,j,t}$ | | | | | | 0.0005 |
| | | | | | | (0.034) |
| N | 2272600 | 1822461 | 1822461 | 1822461 | 1822461 | 1822461 |
| Country-HS4 FE | No | Yes | Yes | Yes | Yes | Yes |
| Year FE | No | No | Yes | Yes | Yes | Yes |

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 for OLS and country-level for PPML. Market power is treated as endogenous in Panel A column (7); the instruments are the average import demand elasticity of other countries and the global average export supply elasticity from the perspective of the exporter.

‡ p<0.10, † p<0.05, * p<0.01

**Table 3. Robustness: alternative samples**

**A: Fixed Effects OLS**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| $BC_{i,t-1}$ | 8.7354‡ | 7.9112‡ | 9.5118‡ | 7.7677‡ | 9.5789 | 7.2969‡ | 14.4986* |
| | (4.6802) | (4.2392) | (4.9939) | (4.4981) | (6.188) | (4.3761) | (5.0964) |
| $y_{i,t-1}$ | -4.4140† | -3.9720* | -5.0263† | -4.5615† | -4.4973† | -3.8394‡ | -5.0473† |
| | (1.7855) | (1.5146) | (1.9908) | (1.8668) | (1.7771) | (1.9762) | (2.0789) |
| $MP_{i,j}$ | -0.0070† | 0.0089 | 0 | 0.0005 | 0.0003 | 0.0048 | -0.0022 |
| | (0.0031) | (0.0109) | (0.01) | (0.0093) | (0.0089) | (0.0136) | (0.0078) |
| $PTA\_IM_{i,j,t}$ | 0.1644 | 0.0783 | 0.2692‡ | 0.2424‡ | 0.2331‡ | 0.1435 | 0.2190‡ |
| | (0.1448) | (0.1323) | (0.1458) | (0.1354) | (0.1335) | (0.142) | (0.1314) |
| N | 2082311 | 1650948 | 2029535 | 2180332 | 2229662 | 1561343 | 1886299 |
| Country-HS4 FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

**B: Fixed Effects PPML**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| $BC_{i,t-1}$ | 1.0179† | 0.9065† | 1.0356† | 0.9183‡ | 0.955 | 0.8311‡ | 1.1792† |
| | (0.4955) | (0.434) | (0.503) | (0.4714) | (0.6495) | (0.4785) | (0.5782) |
| $y_{i,t-1}$ | -0.5795 | -0.5517 | -0.7023 | -0.6607 | -0.5374 | -0.4557 | -0.6115 |
| | (0.5363) | (0.4631) | (0.5846) | (0.5604) | (0.501) | (0.542) | (0.5261) |
| $MP_{i,j}$ | -0.0010‡ | 0.0012 | 0 | 0.0001 | 0.0001 | 0.0006 | -0.0003 |
| | (0.0005) | (0.0019) | (0.0017) | (0.0016) | (0.0015) | (0.0018) | (0.0013) |
| $PTA\_IM_{i,j,t}$ | -0.011 | -0.0219 | 0.0011 | 0.001 | 0.0009 | -0.0006 | 0.0061 |
| | (0.0423) | (0.0376) | (0.0361) | (0.0338) | (0.0341) | (0.0334) | (0.0315) |
| N | 1679395 | 1243038 | 1598036 | 1738290 | 1788306 | 1378223 | 1509725 |
| Country-HS4 FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

Notes: The columns modify the sample from Table 2 in the following ways:
(1) Excludes agriculture.
(2) Excludes HS6 lines with more than one product
(3) Excludes new WTO members.
(4) Excludes EU and China.
(5) Excludes business cycle observations in the top and bottom 1% of the business cycle distribution.
(6) Excludes observations with (i) negative overhang or observations where the tariff drops back below the binding.
and (ii) country-product pairs with non-constant binding, no binding or zero binding,
(7) Excludes Great Recession years (2010 and 2011)
For standard errors, see Table 2.
‡ p<0.10, † p<0.05, * p<0.01

**Table 4. Cyclicality of tariffs by level of development**

**A. Baseline specification**

| | Developing | | Developed | |
|---|---|---|---|---|
| | OLS | PPML | OLS | PPML |
| | (6) | (6) | (6) | (6) |
| $BC_{i,t-1}$ | 10.8589‡ | 0.9462† | -0.595 | -0.2771 |
| | (5.7113) | (0.4802) | (1.0783) | (0.3765) |
| $y_{i,t-1}$ | -8.0090† | -0.0008 | 0.6857* | 0.0028 |
| | (3.4283) | (0.0006) | (0.2443) | (0.0058) |
| $MP_{i,j}$ | -0.008 | -0.0071 | 0.0101 | 0.0822* |
| | (0.0065) | (0.0358) | (0.0178) | (0.0315) |
| $PTA\_IM_{i,j,t}$ | 0.1973 | -0.7155 | 0.2820* | 0.1802 |
| | (0.1677) | (0.6316) | (0.054) | (0.1323) |
| N | 1516616 | 1378299 | 755592 | 443400 |

**B. OLS robustness: developing countries**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| $BC_{i,t-1}$ | 12.3723† | 11.3064† | 14.9529† | 11.6946† | 13.3325‡ | 10.0309‡ | 10.0309‡ |
| | (5.9244) | (5.4665) | (6.4282) | (5.7747) | (8.0144) | (5.3666) | (5.3666) |
| $y_{i,t-1}$ | -8.4381† | -8.3150* | -13.0730* | -10.9527* | -7.9295† | -6.4626‡ | -6.4626‡ |
| | (3.5625) | (3.0548) | (4.6029) | (4.004) | (3.4669) | (3.5604) | (3.5604) |
| $MP_{i,j}$ | -0.0089‡ | 0.0013 | -0.0108 | -0.0089 | -0.0081 | -0.0088 | -0.0088 |
| | (0.0049) | (0.0051) | (0.0077) | (0.0069) | (0.0065) | (0.0061) | (0.0061) |
| $PTA\_IM_{i,j,t}$ | 0.1156 | 0.0013 | 0.2679 | 0.2057 | 0.2223 | 0.2253 | 0.2253 |
| | (0.1797) | (0.1682) | (0.1848) | (0.1666) | (0.1695) | (0.1708) | (0.1708) |
| N | 1410650 | 1112889 | 1302770 | 1479215 | 1488534 | 1133389 | 1133389 |

**C. OLS robustness: developed countries**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| $BC_{i,t-1}$ | -0.8679 | -0.7048 | -0.7818 | -0.6182 | -0.512 | -1.1698 | -1.1698 |
| | (1.2145) | (1.0682) | (1.1391) | (1.0743) | (1.5763) | (1.7982) | (1.7982) |
| $y_{i,t-1}$ | 0.7501* | 0.6549* | 0.6936* | 0.8350* | 0.7185* | 0.7432‡ | 0.7432‡ |
| | (0.2633) | (0.246) | (0.2452) | (0.2543) | (0.2761) | (0.3913) | (0.3913) |
| $MP_{i,j}$ | -0.0047 | 0.0189 | 0.01 | 0.0104 | 0.0101 | 0.0307 | 0.0307 |
| | (0.0034) | (0.0249) | (0.0183) | (0.0179) | (0.018) | (0.0379) | (0.0379) |
| $PTA\_IM_{i,j,t}$ | 0.3094* | 0.2199* | 0.2882* | 0.2877* | 0.2845* | 0.2417* | 0.2417* |
| | (0.0458) | (0.0415) | (0.0553) | (0.0572) | (0.0549) | (0.0732) | (0.0732) |
| N | 671378 | 537653 | 726455 | 700805 | 740791 | 427671 | 427671 |

**D. PPML robustness: developing countries**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| $BC_{i,t-1}$ | 1.1063† | 0.9776† | 1.1306† | 1.0063† | 1.0595 | 0.9550‡ | 1.2731† |
| | (0.5078) | (0.4423) | (0.5066) | (0.4859) | (0.6927) | (0.5101) | (0.6067) |
| $y_{i,t-1}$ | -0.0009‡ | 0 | -0.001 | -0.0009 | -0.0008 | -0.0009 | -0.0010‡ |
| | (0.0005) | (0.0005) | (0.0007) | (0.0006) | (0.0006) | (0.0007) | (0.0005) |
| $MP_{i,j}$ | -0.0204 | -0.0305 | -0.0075 | -0.0062 | -0.0064 | -0.002 | -0.0004 |
| | (0.0444) | (0.0397) | (0.0375) | (0.0349) | (0.0359) | (0.0351) | (0.0332) |
| $PTA\_IM_{i,j,t}$ | -0.775 | -0.7508 | -0.9971 | -0.9391 | -0.6983 | -0.6461 | -0.7822 |
| | (0.6676) | (0.5683) | (0.7484) | (0.6963) | (0.6322) | (0.7346) | (0.6401) |
| N | 1279414 | 975528 | 1181712 | 1342210 | 1351346 | 1044754 | 1138359 |

**Table 4 (continued). Cyclicality of tariffs by level of development**

**E. PPML robustness: developed countries**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| $BC_{i,t-1}$ | -0.4714 | -0.5222 | -0.3859 | -0.3139 | -0.3246 | -0.2144 | 0.069 |
| | (0.4492) | (0.4673) | (0.441) | (0.4028) | (0.4653) | (0.3236) | (0.4507) |
| $y_{i,t-1}$ | 0.2311‡ | 0.2375‡ | 0.1866 | 0.2463† | 0.1945 | 0.1573 | 0.1684 |
| | (0.1268) | (0.1243) | (0.1138) | (0.1136) | (0.1186) | (0.1101) | (0.1318) |
| $MP_{i,j}$ | -0.0014 | 0.0065 | 0.0028 | 0.0029 | 0.0027 | 0.0049 | 0.002 |
| | (0.0014) | (0.0102) | (0.006) | (0.0058) | (0.0058) | (0.0064) | (0.0052) |
| $PTA\_IM_{i,j,t}$ | 0.0927* | 0.0663* | 0.0852* | 0.0871† | 0.0820* | 0.0542† | 0.0829* |
| | (0.0261) | (0.0201) | (0.033) | (0.0352) | (0.0318) | (0.0236) | (0.0312) |
| N | 401818 | 268926 | 418672 | 398069 | 438930 | 335665 | 370618 |

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. The robustness exercises are the same as Table 3. All specifications contain country-HS4 and year fixed effects.

‡ p<0.10, † p<0.05, * p<0.01

**Table 5. Robustness: alternative covariates**

**A. Import surges**

| | Overall | | Developing | | Developed | |
|---|---|---|---|---|---|---|
| | OLS | PPML | OLS | PPML | OLS | PPML |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $\overline{BC}_{i,t-1}$ | 8.3132‡ | 0.9461‡ | 12.2309† | 1.0430† | -0.6402 | -0.4801 |
| | 4.8613 | 0.4896 | 6.1768 | 0.4998 | 1.2632 | 0.4577 |
| $\Delta IM_{i,j,t-1}$ | -0.0262† | -0.0025 | -0.0219 | -0.0024 | -0.0043 | -0.002 |
| | 0.0126 | 0.002 | 0.0156 | 0.0021 | 0.0109 | 0.0022 |
| $sd\Delta\, IM_{i,j,t-1}$ | 0.0284 | 0.0039 | -0.0099 | -0.0015 | 0.1749 | 0.0506 |
| | 0.0354 | 0.0056 | 0.0208 | 0.0031 | 0.1329 | 0.034 |
| N | 2001152 | 1605597 | 1330883 | 1212010 | 669797 | 392845 |

**B. Global business cycle**

| | Overall | | Developing | | Developed | |
|---|---|---|---|---|---|---|
| | OLS | PPML | OLS | PPML | OLS | PPML |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $\overline{BC}_{i,t-1}$ | 7.6746‡ | 0.8893‡ | 11.4558† | 0.9670† | -0.7301 | -0.3703 |
| | (4.4828) | (0.4585) | (5.7485) | (0.4708) | (1.1026) | (0.3886) |
| $GBC_{i,t-1}$ | -17.2749 | -2.3434 | -36.6919 | -2.6668 | 16.5353† | 4.7614 |
| | (16.4375) | (2.0204) | (22.5883) | (2.1349) | (7.091) | (2.9351) |
| N | 2272520 | 1822461 | 1516616 | 1378299 | 755592 | 443400 |

**C. Intermediates**

| | Overall | | Developing | | Developed | |
|---|---|---|---|---|---|---|
| | OLS | PPML | OLS | PPML | OLS | PPML |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $\overline{BC}_{i,t-1}$ | 7.7347‡ | 0.8575‡ | 11.1771† | 0.9584† | -0.8615 | -0.4213 |
| | (4.2622) | (0.446) | (5.592) | (0.4634) | (1.1147) | (0.4032) |
| $Intermed_j$ | -0.6140* | -0.0978* | -0.7985* | -0.1004* | -0.2183* | -0.0838* |
| | (0.0735) | (0.0267) | (0.1019) | (0.0305) | (0.0584) | (0.0273) |
| $Intermed_j * BC_{i,t-1}$ | -0.4282 | 0.009 | -0.5305 | -0.029 | 0.5065 | 0.3592 |
| | (1.811) | (0.2032) | (2.514) | (0.2145) | (0.7493) | (0.5091) |
| N | 2209607 | 1770226 | 1475459 | 1339603 | 733841 | 429888 |
| Joint significance p-value | 0.1189 | 0.0823 | 0.0740 | 0.0722 | 0.7682 | 0.9085 |

**D. Temporary Trade Barriers**

| | Overall | | Developing | | Developed | |
|---|---|---|---|---|---|---|
| | OLS | PPML | OLS | PPML | OLS | PPML |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $\overline{BC}_{i,t-1}$ | 7.4822‡ | 0.8734‡ | 10.8991‡ | 0.9529‡ | -0.595 | -0.2776 |
| | (4.4113) | (0.4689) | (5.6903) | (0.4873) | (1.0776) | (0.3756) |
| $TTB_{i,j,t}$ | 0.7683* | 0.0950† | 1.2888* | 0.1118† | 0.1584‡ | 0.0415* |
| | (0.2414) | (0.0463) | (0.3645) | (0.053) | (0.0835) | (0.0077) |
| $TTB_{i,j,t} * BC_{i,t-1}$ | -7.0513 | -0.8234 | -8.5216 | -0.9007 | 0.5256 | 0.106 |
| | (9.4598) | (0.5174) | (11.4933) | (0.5631) | (2.4051) | (0.4586) |
| N | 2272520 | 1822461 | 1516616 | 1378299 | 755592 | 443400 |
| Joint significance p-value | 0.9690 | 0.9154 | 0.8600 | 0.9153 | 0.9802 | 0.8043 |

**Table 5 (cont.). Robustness: alternative covariates**

**E. Alternative Business Cycle Measures: Baxter-King Filter**

| | Overall | | Developing | | Developed | |
|---|---|---|---|---|---|---|
| | OLS | PPML | OLS | PPML | OLS | PPML |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $BC_{i,t-1}$ | 8.2581‡ | 0.9961† | 12.0997† | 1.1006† | -0.5666 | -0.2499 |
| | (4.7246) | (0.4941) | (6.1655) | (0.515) | (1.1582) | (0.3773) |
| N | 2272520 | 1822461 | 1516616 | 1378299 | 755592 | 443400 |

**F. Alternative Business Cycle Measures: Chirstiano-Fitzgerald Filter**

| | Overall | | Developing | | Developed | |
|---|---|---|---|---|---|---|
| | OLS | PPML | OLS | PPML | OLS | PPML |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $BC_{i,t-1}$ | 7.0374 | 0.9118† | 11.1287 | 1.0291† | -1.0272 | -0.4056 |
| | (5.1905) | (0.4493) | (6.9462) | (0.4713) | (1.3032) | (0.3672) |
| N | 2272520 | 1822461 | 1516616 | 1378299 | 755592 | 443400 |

Notes: All specifications include market power, PTA import share and lagged trend of log real GDP as controls and include year and country-HS4 fixed effects. All specifications use the same sample and standard errors as Table 2. Joint signifiance p-value relates to joint significance of the business cycle and the interaction with the business cycle.
‡ p<0.10, † p<0.05, * p<0.01

**Table 6. Cyclicality of country-level aggregate tariffs**

**A. Simple average tariff without additional controls**

| | OLS | | | PPML | | |
|---|---|---|---|---|---|---|
| | Overall | Developing | Developed | Overall | Developing | Developed |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $\overline{BC}_{i,t-1}$ | 1.212 | 1.287 | 0.43 | 0.115 | 0.095 | 0.103 |
| | (2.978) | (4.352) | (1.154) | (0.307) | (0.357) | (0.399) |
| N | 763 | 551 | 212 | 715 | 551 | 164 |
| Country FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |

**B. Weighted average tariff without additional controls**

| | OLS | | | PPML | | |
|---|---|---|---|---|---|---|
| | Overall | Developing | Developed | Overall | Developing | Developed |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $\overline{BC}_{i,t-1}$ | 3.074 | 1.71 | 6.135‡ | 0.441 | 0.091 | 2.213† |
| | (3.528) | (5.705) | (3.435) | (0.473) | (0.565) | (0.953) |
| N | 656 | 453 | 203 | 608 | 453 | 155 |
| Country FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |

**C. Simple average tariff with additional controls**

| | OLS | | | PPML | | |
|---|---|---|---|---|---|---|
| | Overall | Developing | Developed | Overall | Developing | Developed |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $\overline{BC}_{i,t-1}$ | 3.409 | 4.042 | -0.406 | 0.406 | 0.372 | -0.173 |
| | (3.343) | (4.766) | (1.221) | (0.301) | (0.338) | (0.467) |
| $y_{i,t-1}$ | -85.47 | -203.578‡ | 11.758 | -14.370‡ | -19.409‡ | 4.178 |
| | (69.192) | (119.026) | (10.784) | (8.044) | (9.961) | (3.141) |
| $PTA\_IM_{i,t}$ | -0.81 | -1.543 | 0.517 | -0.264 | -0.254 | -0.208 |
| | (2.106) | (2.419) | (0.760) | (0.168) | (0.173) | (0.429) |
| | 763 | 551 | 212 | 715 | 551 | 164 |
| Country FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |

**Table 6 (cont.). Cyclicality of country-level aggregate tariffs**

**D. Weighted average tariff with additional controls**

| | OLS | | | PPML | | |
|---|---|---|---|---|---|---|
| | Overall | Developing | Developed | Overall | Developing | Developed |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $\overline{BC}_{i,t-1}$ | 3.585 | 3.59 | 4.311 | 0.6 | 0.358 | 1.287 |
| | (3.554) | (5.734) | (2.987) | (0.462) | (0.547) | (0.912) |
| $y_{i,t-1}$ | -42.837 | -132.411 | 28.821‡ | -8.407 | -16.084 | 16.281* |
| | (58.817) | (133.857) | (13.902) | (9.219) | (12.584) | (6.150) |
| $PTA\_IM_{i,t}$ | 1.32 | 0.85 | 1.02 | 0.064 | 0.035 | 0.107 |
| | (1.300) | (1.594) | (0.940) | (0.182) | (0.188) | (0.373) |
| N | 656 | 453 | 203 | 608 | 453 | 155 |
| Country FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |

Notes: The country-year pairs included in the sample correspond to the country-year pairs in the sample of Table 2. Standard errors clustered by country.

‡ p<0.10, † p<0.05, * p<0.01

**Table 7. Cyclicality of tariffs and market power**

**A. Cyclicality and time invariant market power**

| | OLS | | | | PPML | | | |
|---|---|---|---|---|---|---|---|---|
| | Developing | | Developed | | Developing | | Developed | |
| | Low MP | High MP | Low MP | High MP | Low MP | High MP | Low MP | High MP |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| $\overline{BC}_{i,t-1}$ | 4.4719 | 11.9867‡ | -0.3467 | -0.0655 | 0.4981 | 1.0356‡ | -0.0063 | -0.0477 |
| | (5.1776) | (6.3935) | (0.8884) | (1.1372) | (0.3907) | (0.5305) | (0.4216) | (0.3154) |
| N | 467990 | 301516 | 109331 | 266197 | 418135 | 269874 | 57814 | 165435 |

**B. Cyclicality and time varying market power in developing countries (OLS)**

| | OLS | | | PPML | | |
|---|---|---|---|---|---|---|
| | Overall | Extreme 1/3's | Mid 1/3 | Overall | Extreme 1/3's | Mid 1/3 |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $\overline{BC}_{i,t-1}$ | 13.2511‡ | 17.1098† | 6.2825 | 1.1369† | 1.4227† | 0.611 |
| | (6.8198) | (8.4741) | (5.4499) | (0.5584) | (0.6842) | (0.5034) |
| $IM^{Share}_{i,j,t-1}$ | -0.1117* | -0.1204* | -0.0832 | -0.0086† | -0.0088 | -0.0070‡ |
| | (0.0292) | (0.0379) | (0.036) | (0.0046) | (0.0063) | (0.0038) |
| N | 276601 | 183447 | 90037 | 248089 | 163949 | 80063 |

Notes: In Panel A, high (low) market power are observations in the top 25% (bottom 25%) of the market power distribution. In Panel B, Overall are all developing country high market power observations, Extreme 1/3's are observations in the top 1/3 or bottom 1/3 of the relevant $\widetilde{m}_{i,j,t}$ distribution, and Mid 1/3 are observations in the middle 1/3 of the relevant $\widetilde{m}_{i,j,t}$ distribution (see text for more details). All specifications include market power, PTA import share and lagged trend of log real GDP as controls and include year and country-HS4 fixed effects. All specifications use the same standard errors as Table 2.

‡ p<0.10, † p<0.05, * p<0.01

**Table 8. Cyclicality of tariffs and temporal fluctuations in imports**

**A. Cyclicality and log real imports**

| | OLS | | | PPML | | |
|---|---|---|---|---|---|---|
| | Overall | Extreme 1/3's | Mid 1/3 | Overall | Extreme 1/3's | Mid 1/3 |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $BC_{i,t-1}$ | 11.2805‡ | 12.9176† | 6.893 | 1.0089‡ | 1.1564† | 0.5619 |
| | (6.5721) | (6.4333) | (6.8245) | (0.5702) | (0.5733) | (0.6056) |
| $IM_{i,j,t-1}$ | -0.0734* | -0.0710* | -0.1094* | -0.0068 | -0.0064 | -0.0125* |
| | (0.0246) | (0.025) | (0.0326) | (0.0048) | (0.0049) | (0.0041) |
| $sdIM_{i,j,t-1}$ | -0.1393‡ | -0.135 | -0.2289 | -0.0141 | -0.014 | -0.0297 |
| | (0.0846) | (0.0841) | (0.1459) | (0.0123) | (0.0121) | (0.0198) |
| N | 231022 | 160792 | 67637 | 205072 | 142394 | 59291 |

**B. Cyclicality and detrended log real imports**

| | OLS | | | PPML | | |
|---|---|---|---|---|---|---|
| | Overall | Extreme 1/3's | Mid 1/3 | Overall | Extreme 1/3's | Mid 1/3 |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| $BC_{i,t-1}$ | 11.4716‡ | 12.8092† | 7.2073 | 1.0214‡ | 1.2034† | 0.3816 |
| | (6.6736) | (5.8991) | (8.7232) | (0.575) | (0.5611) | (0.7509) |
| $\Delta IM_{i,j,t-1}$ | -0.0124 | -0.0165 | -0.2002 | -0.0014 | -0.0019 | -0.0142 |
| | (0.0157) | (0.0146) | (0.203) | (0.002) | (0.0019) | (0.0298) |
| $sd\Delta IM_{i,j,t-1}$ | -0.1005 | -0.0834 | -0.1126 | -0.0125‡ | -0.011 | -0.0127 |
| | (0.0638) | (0.0644) | (0.1311) | (0.0074) | (0.0072) | (0.018) |
| N | 224558 | 154147 | 67993 | 199315 | 135567 | 60630 |

Notes: In Panels A and B, Overall are all developing country observations that lie in the top 25% of the distribution over the product of the inverse export supply elasticity and the inverse import demand elasticity. Extreme 1/3's are observations in the top 1/3 or bottom 1/3 of the relevant $\widetilde{m}_{i,j,t}$ distribution, and Mid 1/3 are observations in the middle 1/3 of the relevant $\widetilde{m}_{i,j,t}$ distribution (see text for more details). All specifications include market power, PTA import share and lagged trend of log real GDP as controls and include year and country-HS4 fixed effects. All specifications use the same standard errors as Table 2.

‡ 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 (7)**
Australia, Canada, European Union, Japan, Norway, Singapore, United States

**Only missing GDP years (5)**
Brunei (1960-1973), Hong Kong (1960-1964), Macao (1960-1981), New Zealand (1960-1976), Switzerland (1960-1979)

**Only missing tariff years (2)**
Iceland (2002), Israel (2010)

**Missing GDP years and tariff years (2)**
Qatar (missing GDP years 1960-1969, 2013; missing tariff years 2000-2001),
Saudi Arabia (missing GDP years 1960-1967; missing tariff year 2010; joined WTO 12/11/2005)

**<u>Developing (51)</u>**
**All tariff years and all GDP years (22)**
Argentina, Brazil, Chile, Colombia, Costa Rica, Guatemala, Honduras, Indonesia, Madagascar Malaysia, Mexico, Nicaragua, Paraguay, Peru, Philippines, South Africa, Togo, Turkey, Venezuela, Ecuador (joined WTO 1/21/1996), Nepal (joined WTO 4/23/2004), Panama (joined WTO 9/6/1997)

**Only missing GDP years (7)**
Cuba (1960-1969, 2012-2013), 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),

**Only missing tariff years (17)**
Bangladesh (2001), Bolivia (2011), Cameroon (2000), Central African Republic (2000), Cote d'Ivoire (2000), Gabon (2006), Ghana (2005-2006, 2011), Guyana (2004-2005), India (2003), Kenya (2003), Niger (2000) Papua New Guinea (2011), Senegal (2000), Sri Lanka (2002), Uruguay (2003), Zambia (2000), China (missing tariff year 2011, joined WTO 12/11/2001)

**Missing GDP and tariff years (5)**
Jordan (missing GDP years 1960-1974; msising tariff year 2011; joined WTO 4/11/2000), Mali (1960-1966; 2000-01), Mauritius (1960-1975; 2003), Tunisia (1960-1964; 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 GDP years 1960-1976)
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. (2015) with new members included in our regressions in their first full year of WTO membership. All tariff years = 2000-2011 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/) |
| $y_{i,t-1}$ | Trend component in year t-1 of country i's log real GDP using Hodrick Prescott filter with real GDP measured in local currency units | |
| $MP_{i,j}$ | 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 | WITS (http://wits.worldbank.org/data/public/concordance/Concordance_HS_to_BE.zip); RIETI (http://www.rieti.go.jp/en/projects/rieti-tid/pdf/1503.pdf) |
| $TTB_{i,j,t}$ | = 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/) |
| $IM_{i,j,t-1}$ | Change in country i log imports of product j between years t-1 and t-2 (000's million 2010 USD) | COMTRADE (http://wits.worldbank.org/); http://data.worldbank.org/indicator/FP.CPI.TOTL |
| $sdIM_{i,j,t-1}$ | Standard deviation of $IM_{i,j,t-1}$ over the sample period | |
| $\Delta IM_{i,j,t-1}$ | Change in first differenced country i log imports of product j between t-1 and t-2 (000's million 2010 USD) | |
| $sd\Delta IM_{i,j,t-1}$ | Standard deviation of $\Delta IM_{i,j,t-1}$ over the sample period | |
| $\Delta IM_{i,j,t-1}^{Share}$ | Change in country i's log share of world imports of product j between years t -1 and t-2 (000's million 2010 USD) | |
| **Instruments** | | |
| $\eta_j^{IM}$ | Global average of rest of the world product j import demand elasticity | Nicita et. al. (2013) |
| $\eta_j^{EX}$ | Global average of product j export supply elasticity from perspective of exporter | |

**Table A2 (continued). Variable definitions and sources**

| Variable | Description | Source |
|---|---|---|
| **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 year t is zero and = 0 otherwise | |
| **Aggregate data** | | |
| $\tau_{i,t}^{simple}$ | Simple average applied tariff of country i in year t | WTO Integrated Database (http://wits.worldbank.org/) |
| $\tau_{i,t}^{weighted}$ | Weighted average applied tariff of country i in year t | |
| $PTA\_IM_{i,t}$ | Weighted share of country i's imports in year t sourced from countries who are FTA or CU partners of country i. The (time-invariant) weights use import shares 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) |

**Table A3. Summary statistics**

| | All countries | | | | |
|---|---|---|---|---|---|
| | **N** | **Mean** | **St. Dev.** | **Min.** | **Max.** |
| **Tariff variables** | | | | | |
| $\tau_{i,j,t}$ | 2272600 | 7.8769 | 14.5408 | 0 | 3000 |
| **Covariates** | | | | | |
| $BC_{i,t-1}$ | 2272600 | -0.0008 | 0.0199 | -0.13 | 0.09 |
| $y_{i,j,t-1}$ | 2272600 | 27.7673 | 3.0237 | 21.49 | 35.38 |
| $MP_{i,j}$ | 2272600 | -2.7222 | 3.1164 | -11.40 | 21.72 |
| $PTA\_IM_{i,j,t}$ | 2272600 | 0.2867 | 0.3635 | 0 | 1 |
| $Intermed_j$ | 2209696 | 0.5589 | 0.4965 | 0 | 1 |
| $TTB_{i,j,t}$ | 2272600 | 0.0117 | 0.1073 | 0 | 1 |
| $GBC_{i,t-1}$ | 2272600 | -0.0001 | 0.0133 | -0.05 | 0.03 |
| $\Delta IM_{i,j,t-1}$ | 2006671 | 0.0561 | 1.0147 | -14.09 | 16.30 |
| $sd\Delta IM_{i,j,t-1}$ | 2006671 | 0.0049 | 0.9866 | -14.21 | 16.04 |
| $IM_{i,j,t-1}^{Share}$ | 2086252 | 0.0172 | 0.0505 | 0 | 1 |
| $IM_{i,j,t-1}$ | 2071519 | -4.4099 | 2.5512 | -18.42 | 6.74 |
| $sdIM_{i,j,t-1}$ | 2071519 | 0.0372 | 0.9632 | -13.04 | 10.17 |
| **Instruments** | | | | | |
| $\eta_j^{IM}$ | 1559575 | 1.5588 | 2.2015 | 0.00 | 28.91 |
| $\eta_j^{EX}$ | 1618816 | 36.703 | 170.835 | 0.44 | 6800.29 |
| **Other** | | | | | |
| $\bar{\tau}_{i,j,t}$ | 1877097 | 22.455 | 23.137 | 0 | 3000 |
| $Unbound_{i.j}$ | 2272600 | 0.1740 | 0.3791 | 0 | 1 |
| *Zero tariff binding* | 2272600 | 0.1053 | 0.3070 | 0 | 1 |
| **Aggregate data** | | | | | |
| $\tau_{i,t}^{simple}$ | 763 | 8.63688 | 5.48268 | 0.00 | 33.71 |
| $\tau_{i,t}^{Weighted}$ | 656 | 6.46713 | 4.24625 | 0.00 | 24.54 |
| $BC_{i,t-1}$ | 763 | -0.0007 | 0.02012 | -0.11 | 0.09 |
| $y_{i,t-1}$ | 763 | 27.2622 | 2.96249 | 21.52 | 35.38 |
| $PTA\_IM_{i,t}$ | 763 | 0.29031 | 0.25549 | 0.00 | 0.90 |

**Table A3 (continued). Summary statistics**

| | Developed | | | | | Developing | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | N | Mean | St. Dev. | Min. | Max. | N | Mean | St. Dev. | Min. | Max. |
| **Tariff variables** | | | | | | | | | | |
| $\tau_{i,j,t}$ | 755628 | 3.4736 | 9.6376 | 0 | 800.3 | 1516972 | 10.0703 | 16.0006 | 0 | 3000 |
| **Covariates** | | | | | | | | | | |
| $BC_{i,t-1}$ | 755628 | -0.0002 | 0.0195 | -0.11 | 0.09 | 1516972 | -0.0011 | 0.0201 | -0.13 | 0.08 |
| $y_{i,t}$ | 755628 | 28.2311 | 3.0539 | 21.55 | 34.77 | 1516972 | 27.536 | 2.982 | 21.49 | 35.38 |
| $MP_{i,j}$ | 755628 | -1.7142 | 3.8879 | -11.04 | 21.72 | 1516972 | -3.2242 | 2.5025 | -11.40 | 20.73 |
| $PTA\_IM_{i,j,t}$ | 755628 | 0.3274 | 0.3655 | 0 | 1 | 1516972 | 0.2665 | 0.3608 | 0 | 1 |
| $Intermed_j$ | 733886 | 0.5436 | 0.4981 | 0 | 1 | 1475810 | 0.5665 | 0.4956 | 0 | 1 |
| $TTB_{i,j,t}$ | 755628 | 0.0158 | 0.1249 | 0 | 1 | 1516972 | 0.0096 | 0.0973 | 0 | 1 |
| $GBC_{i,t-1}$ | 755628 | 0.0002 | 0.0124 | -0.04 | 0.02 | 1516972 | -0.0002 | 0.0138 | -0.05 | 0.03 |
| $\Delta IM_{i,j,t-1}$ | 671494 | 0.0363 | 0.8068 | -13.77 | 14.05 | 1335177 | 0.0661 | 1.1044 | -14.09 | 16.30 |
| $sd\Delta IM_{i,j,t-1}$ | 671494 | 0.0049 | 0.7808 | -12.51 | 13.95 | 1335177 | 0.0048 | 1.0753 | -14.21 | 16.04 |
| $IM^{Share}_{i,j,t-1}$ | 695676 | 0.0370 | 0.0748 | 0.00 | 1.00 | 1390576 | 0.0074 | 0.0270 | 0 | 1 |
| $IM_{i,j,t-1}$ | 690322 | -3.4002 | 2.6515 | -18.41 | 6.74 | 1381197 | -4.9146 | 2.3417 | -18.42 | 6.64 |
| $sdIM_{i,j,t-1}$ | 690322 | 0.0322 | 0.7850 | -11.92 | 10.17 | 1381197 | 0.0397 | 1.0408 | -13.04 | 9.28 |
| **Instruments** | | | | | | | | | | |
| $\eta_j^{IM}$ | 566192 | 1.5270 | 2.2179 | 0 | 28.90 | 993383 | 1.5769 | 2.1920 | 0.02 | 28.91 |
| $\eta_j^{EX}$ | 573627 | 43.402 | 215.127 | 0.44 | 6800.29 | 1045189 | 33.026 | 140.585 | 0.44 | 6800.29 |
| **Other** | | | | | | | | | | |
| $\bar{\tau}_{i,j,t}$ | 661936 | 10.063 | 16.469 | 0 | 800.3 | 1215161 | 29.206 | 23.451 | 0 | 3000 |
| $Unbound_{i.j}$ | 755628 | 0.1240 | 0.3296 | 0 | 1 | 1516972 | 0.1990 | 0.3992 | 0 | 1 |
| *Zero tariff binding* | 755628 | 0.2627 | 0.4401 | 0 | 1 | 1516972 | 0.0269 | 0.1618 | 0 | 1 |
| **Aggregate data** | | | | | | | | | | |
| $\tau_{i,t}^{simple}$ | 212 | 3.4758 | 2.9063 | 0.00 | 12.42 | 551 | 10.6226 | 4.9182 | 0.91 | 33.71 |
| $\tau_{i,t}^{weighted}$ | 203 | 2.7784 | 2.4496 | 0.00 | 14.21 | 453 | 8.1201 | 3.8207 | 0.85 | 24.54 |
| $BC_{i,t-1}$ | 212 | -0.0002 | 0.0223 | -0.11 | 0.09 | 551 | -0.0009 | 0.0192 | -0.11 | 0.08 |
| $y_{i,t-1}$ | 212 | 27.490 | 3.199 | 21.55 | 34.77 | 551 | 27.174 | 2.865 | 21.52 | 35.38 |
| $PTA\_IM_{i,t}$ | 212 | 0.3641 | 0.2658 | 0.00 | 0.85 | 551 | 0.2619 | 0.2458 | 0.00 | 0.90 |

Notes: See Table A2 for a description of variables and data sources.