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Tariffs and Growth

HETEROGENEITY BY ECONOMIC STRUCTURE

MATEO HOYOS

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Abstract

This paper documents that the relationship between tariffs and growth varies significantly with economic structure. Using a panel of 161 countries from 1960 to 2019 and employing a local projections difference-in-differences strategy, I show that tariff reductions are associated with higher GDP per capita in manufacturer countries but lower GDP per capita in nonmanufacturer ones. I then reveal that these results are consistent with, and possibly explained by, heterogeneous changes in productivity, capital accumulation, and the manufacturing share of GDP. The heterogeneity is further confirmed by a comprehensive set of robustness checks. The findings suggest that the recent rise in protectionism in manufacturer countries might end up being harmful, and that existing calls for further liberalization in nonmanufacturers could have unintended consequences.

Keywords: tariffs, trade liberalization, trade policy, growth, economic structure.
JEL Codes: F14, F63, O24, O47.

Resumen

Este artículo documenta que la relación entre los aranceles y el crecimiento varía significativamente según la estructura económica. Utilizando un panel de 161 países desde 1960 hasta 2019 y empleando una estrategia de diferencias en diferencias con proyecciones locales, muestro que las reducciones arancelarias están asociadas con un mayor PIB per cápita en países manufactureros, pero con un menor PIB per cápita en países no manufactureros. Luego, revelo que estos resultados son consistentes con, y posiblemente explicados por, cambios heterogéneos en la productividad, la acumulación de capital y la participación del sector manufacturero en el PIB. La heterogeneidad se confirma aún más mediante un conjunto exhaustivo de pruebas de robustez. Los hallazgos sugieren que el reciente aumento del proteccionismo en los países manufactureros podría resultar perjudicial, y que los llamados existentes a una mayor liberalización en los países no manufactureros podrían tener consecuencias no deseadas.

Palabras clave: aranceles, liberalización comercial, política comercial, crecimiento, estructura económica.
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Tariffs and Growth: Heterogeneity by Economic Structure*

Mateo Hoyos†

Abstract

This paper documents that the relationship between tariffs and growth varies significantly with economic structure. Using a panel of 161 countries from 1960 to 2019 and employing a local projections difference-in-differences strategy, I show that tariff reductions are associated with higher GDP per capita in manufacturer countries but lower GDP per capita in nonmanufacturer ones. I then reveal that these results are consistent with, and possibly explained by, heterogeneous changes in productivity, capital accumulation, and the manufacturing share of GDP. The heterogeneity is further confirmed by a comprehensive set of robustness checks. The findings suggest that the recent rise in protectionism in manufacturer countries might end up being harmful, and that existing calls for further liberalization in nonmanufacturers could have unintended consequences.

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1 Introduction

A strand of the trade and endogenous growth theoretical literature suggests that the relationship between trade policy and growth sharply varies with economic structure. More specifically, by opening up to trade, countries with comparative advantage in high-tech sectors increase their specialization in those sectors and end up growing faster. Conversely, countries with comparative disadvantage in those sectors are driven by trade opening to reduce their specialization in those sectors and end up growing more slowly. According to Melitz and Redding (2021), "depending on patterns of comparative advantage, the opening of international trade can lead an economy to specialize in the sector with a lower rate of learning by doing, slowing its aggregate rate of economic growth." (p. 23). In short, the relationship between trade policy and growth varies with comparative advantage and could even be negative for some countries.

In this paper, I provide empirical evidence consistent with this view. Using a panel of 161 countries from 1960 to 2019 and a local projections difference-in-differences (LP-DiD) approach, I show that the dynamic association between tariff reductions and growth starkly varies with comparative advantage in manufacturing, which I refer to as economic structure[1]. In other words, among countries with a comparative advantage in manufacturing (simply manufacturers), those with larger tariff reductions grew faster relative to those with smaller reductions. Conversely, among countries with a comparative disadvantage in manufacturing (nonmanufacturers), those with higher tariff reductions experienced slower growth compared to those with smaller reductions. The estimates suggest that a one-standard-deviation tariff reduction (i.e., 3.65 percentage points) is associated with a fall (increase) of more than 2 percent in GDP per capita fifteen years later for nonmanufacturers (manufacturers). I further show that the heterogeneity appears to be linked to changes in productivity and capital accumulation, in turn related to changes in the manufacturing share in GDP. In other

[1] Trade policy is also composed by nontariff barriers, export taxes, among others. Although I focus on tariffs, I nonetheless control for nontariff barriers changes in a couple robustness checks.

words, nonmanufacturers experience deindustrialization following tariff reductions, while manufacturers experience increased levels of industrialization[2].

To establish the baseline results, I first use the LP-DiD approach to address a selection bias of tariff reductions. I document, consistent with previous endogenous trade policy literature, that tariff changes are endogenous to GDP dynamics, meaning that countries reducing (raising) tariffs do so after a relative period of economic success (crisis). More specifically, as shown in Figure 1, countries reducing tariffs (treatment group) are on a different trajectory ex-ante as compared to countries not changing them (control group): GDP of the former is increasing in relative terms before tariff reductions (treatment). Then, to avoid biased dynamic estimates, I use the LP-DiD estimator, which provides a flexible semiparametric approach to control for pre-treatment values, as in conditional parallel trends (Dube, Girardi, Jordà, & Taylor, 2023). In other words, I address the endogeneity of tariff reductions to GDP dynamics by explicitly modeling it in my regressions, as in the empirical application by Acemoglu, Naidu, Restrepo, and Robinson (2019).

Although definitely confirming causality is challenging, I then demonstrate that the baseline heterogeneity is extremely robust. I first check that the results are not driven by any baseline modeling choice, which I call sensitivity checks. The first of these checks is aimed at addressing the biases from negative weights in DiD estimates generated by heterogeneity, recently identified by the literature (de Chaisemartin & d'Haultfoeuille, 2020; Goodman-Bacon, 2021). To do so, I use LP-DiD with sample restrictions to avoid using so-called 'bad controls' in my estimates, following the approach by (de Chaisemartin, D'Haultfœuille, & Vazquez-Bare, 2024) of only comparing movers (here countnry-year observations with significant tariff changes) with untreated quasi-stayer (here country-year observations without significant tariff changes in the current and in previous periods).

[2]Interpreting our results from a comparative advantage lens might particularly connect them to the theory of within-product comparative advantage by French (2016, 2017), according to which in a general trade liberalization domestic producers in sectors with comparative advantage fare better than those in comparative disadvantage sectors.

Then, I perform the analysis using alternative dynamic panel data estimators, especially the debiased Arellano-Bond estimator through sample splitting recently proposed by Chen, Chernozhukov, and Fernández-Val (2019). And finally, I test the sensitivity to other baseline modeling choices, including alternative lag structures to model the selection bias and alternative definitions of economic structure, among others.

The second set of robustness results is aimed to relax my baseline identifying assumption, namely that tariff reductions are, conditional on baseline explicit modeling of the selection bias, as good as random. I relax this assumption in three steps. First, I discuss and control for the most relevant factors determining tariff changes, as discussed in the endogenous trade policy literature, including changes in growth expectations, inequality as a proxy for lobbying, and import penetration. Second, I then control for other potential confounders, such as other policy changes, covariates found to be relevant to explain growth and other heterogeneities in the tarifff-growth nexus. I particularly implement coarser sets of fixed effects, such as trends by regional and income groups of countries, to relax even more my identifying assumption. And third, I use local projections instrumental variables, following the spirit of the approach by Acemoglu et al. (2019) and the specific instrument used by Furceri, Hannan, Ostry, and Rose (2022). Using a trade-weighted average of tariff changes in major trading partners as the instrument, I once again confirm the existence of a significant heterogeneity by economic structure in the tariff-growth nexus[3].

This paper provides two novel contributions to the cross-country tariff-growth nexus empirical literature. First, the paper documents that the relationship between trade liberalization and growth is characterized by a sharp heterogeneity by economic structure, and specifically a negative one in the case of nonmanufacturer countries. Most empirical contributions to date have focused on studying the *average* relationship between trade

[3]Finally, in the Appendix, I conduct three more robustness checks to control for other potential endogeneity threats from i) heterogeneity in the pretreatment-posttreatment growth correlation and heterogeneity in global shocks (i.e. year fixed effects), ii) future tariff changes, and iii) endogeneity of the economic structure.

liberalization and growth, thus in some sense hiding potentially relevant heterogeneities[4]. For instance, compared to the recent contributions by Wacziarg and Welch (2008) and Estevadeordal and Taylor (2013), I here show that the *average positive* relationship they document might mask important heterogeneity, particularly a significant negative relationship for nonmanufacturer countries[5].

The finding of heterogeneity by economic structure has different implications than previous literature that has explored heterogeneity by income in the tariff-growth nexus. Furceri et al. (2022) provide evidence of a potential heterogeneity by income, but the implications of their analysis for nonmanufacturers are markedly different than those found here. I particularly document a negative relationship between tariff reductions and growth for nonmanufacturer countries, while their analysis implies a positive relationship for all countries, including these ones. The negative relationship I document implies substantially different underlying mechanisms, which I document, and very different policy implications relative to a positive relationship[6].

DeJong and Ripoll (2006) also study the heterogeneity by income in the tariff-growth nexus. They find that trade restrictions may encourage growth in developing countries but negatively impact growth in developed countries. Although such a result may be perceived as qualitatively equal to my finding, economic structure and income are far from perfect correlates (i.e., correlation is 0.33), so running the baseline analysis with heterogeneity by income does not yield any significant result[7]. Regarding policy implications, while here the

[4]An early literature review by Rodríguez and Rodrik (2001), in addition to criticizing most contributions in terms of robustness, precisely emphasized the need to explore relevant heterogeneities.

[5]The cross-country tariff-growth nexus empirical literature, as revised by Goldberg and Pavcnik (2016) and Irwin (2019), usually relies on estimates that are not causal, as they do not exploit an arguably exogenous source of variation for tariffs. Notable exceptions are provided by Estevadeordal and Taylor (2013) and Furceri et al. (2022), who use an instrumental variables approach. Although I am careful in avoiding using causal language, I use the latter approach in one of the many robustness checks I perform.

[6]Other differences between my analysis and theirs are that I use the LP-DiD framework instead of standard local projections, I use GDP per capita instead of GDP, and I perform the analysis for a longer horizon, twenty years after tariff reductions instead of only five.

[7]This result is not presented here, but available if requested. Moreover, the heterogeneity by economic structure is significant even when controlling for heterogeneity by income, as shown in Figure B24.

analysis implies that a manufacturer developing economy should reduce tariffs to promote growth (e.g., Vietnam), the analysis by DeJong and Ripoll (2006) would imply that all developing economies should not reduce tariffs[8].

The second novel finding of the paper is the evidence of potential theoretically grounded mechanisms by which the heterogeneity by economic structure might exist. The heterogeneity observed for GDP per capita is also observed for other important variables, mechanisms, such as productivity, capital stocks, and the manufacturing share of GDP. In other words, for nonmanufacturer (manufacturer) countries, I document that tariff reductions are accompanied not only by lower (higher) income but also by lower (higher) productivity, lower (higher) capital stocks, and, critically, lower (higher) shares of manufacturing in GDP. The evidence can also be interpreted to support the premature deindustrialization account by Rodrik (2016), according to which most Latin American and African economies (i.e., nonmanufacturers) prematurely deindustrialized with globalization.

The paper has six sections in addition to this introduction. In section 2, I present the data and some descriptive statistics. In section 3, I use LP-DiD to address the selection bias of tariff reductions to GDP dynamics. In section 4, I present the baseline results, demonstrating the existence of a heterogeneity in the tariff-growth nexus by economic structure. In section 5, I present several robustness checks. In section 6, I show the analysis of potential mechanisms behind the heterogeneity. Finally, in section 7, I conclude the paper.

2 Data and descriptive statistics

I put together a panel of 161 countries covering 1960 to 2019. For the outcome variable in the growth regressions, I use the data of GDP per capita in constant national prices in 2017 dollars taken from the Penn World Table (PWT) 10.0. The tariff data are taken from Furceri

[8]Other important differences are that they use data from 1975 to 2000, and they rely on regressions with 5-year averages instead of annual data. By using yearly data, I am able to model dynamic medium-term effects even twenty years after tariff reductions.

et al. (2022) and represent the import-weighted average tariffs applied in each country in a given year, covering from 1960 to 2014. The coverage of tariff data is lower than that of the GDP data, so I end up using approximately 4,700 observations in the regressions.

How to measure empirically the economic structure? For ease of interpretation, I use the share of manufacturing exports. In short, I assume that countries with high manufacturing exports have a comparative advantage in more dynamic sectors and those with low exports have a comparative disadvantage. Manufacturing is thus assumed to be in broad terms the more dynamic sector and the share of exports assumed to capture comparative advantage. The first condition seems to be backed by the evidence provided by Rodrik (2013) and the second is supported by the data used here[9].

Using data from the Growth Lab at Harvard University, I calculate the share as follows. First, I exclude services exports and exports not elsewhere classified, ending up with a measure of total goods exports. And then, I get the shares by excluding exports in three broad categories of goods from the Standard International Trade Classification (SITC): (i) food and live animals chiefly for food; (ii) crude materials, inedible, except fuels; and (iii) mineral fuels, lubricants and related materials[10]. The data run from 1962 to 2019.

I also gather information on important covariates to control for in the regressions. The dataset has country-year data on the trade share on GDP and investment as a share of GDP, taken from the World Development Indicators (WDI); the economic growth forecast, the net exports terms of trade, and the real effective exchange rate, taken from the IMF; the Gini index, taken from the Standardized World Income Inequality Database by Solt (2020); institutional quality, as measured by the Polity score; the Chinn-Ito index for capital account openness (Chinn & Ito, 2006); the human capital index in PWT, which improves on the traditional measure of years of schooling from Barro and Lee (2013) and has greater

[9] The correlation between the share of manufacturing exports and revealed comparative advantage in manufacturing is 0.98. The results obtained by using revealed comparative advantage, Figure B9, are virtually the same as the baseline results, presented in Figure 3.

[10] Another important goods classification is the one by Lall (2000), based on technological categories. I use this classification in a robustness check, and results remain basically the same.

coverage; and a count variable of nontariff barriers, recently published by Estefania-Flores, Furceri, Hannan, Ostry, and Rose (2022). In a robustness check, I control for regional trends based on the World Bank classification: Africa, East Asia and the Pacific, Eastern Europe and Central Asia, Western Europe and other developed countries, Latin America and the Caribbean, the Middle East and North Africa, and South Asia.

Table 1 presents descriptive statistics of the variables that I use in the analysis. I present a summary of the data in two periods, 1960-1989 and 1990-2019, each covering the same number of years and reflecting two different periods in terms of tariff levels. In the first period, tariffs are higher and more dispersed, with a mean of 18.43 percent and a standard deviation of 20.92, while in the second, the mean is 8.24 percent and the standard deviation 7.56. This grouping in two periods is made only to illustrate that the world has been moving towards a more liberal trade regime. The periods also reveal that the information on tariffs in the first period is scarcer than in the more recent one. Moreover, consistent with a more liberal regime, trade as a share of GDP has increased on average. Likewise, capital accounts have moved towards liberalization, as captured by the Chinn-Ito index. GDP per capita, institutional quality, and human capital improved from the first to the second period. Inequality, as documented extensively elsewhere, increased. The growth forecast is available only from 1990 onward.

3 Selection bias in tariff reductions

In this section, I demonstrate that tariff reductions are subject to selection bias. Specifically, I show that countries tend to reduce tariffs after experiencing rapid GDP growth. To achieve this, I first explain the LP-DiD approach used throughout the paper, and then I use it to identify and purge my tariff-growth associations from this selection bias. To focus on the selection bias, for now I abstract from the heterogeneity by economic structure, and consider only general tariff changes.

Table 1: Summary statistics

Variables	Observ.	Mean	St.Dev.	Observ.	Mean	St.Dev.
	1960-1989			1990-2019		
GDP per capita	4,274	11,089.6	18,480.13	5,460	17,517.09	19,344.82
Tariff	1,675	17.73	20.27	3,367	8.01	7.06
Manufacturing share of exports	4,522	33.72	28.89	6,122	52.35	30.32
Trade share of GDP	2,999	62.68	46.19	5,173	86.69	56.36
Nontariff barriers	3,048	12.97	4.50	4,587	9.46	4.82
Polity score (institutional quality)	3,811	-1.58	7.41	4,504	3.25	6.57
Chinn-Ito Index (capital account openness)	2,465	0.35	0.32	4,945	0.50	0.36
Human capital index	3,644	1.76	0.60	4,350	2.40	0.69
Investment as a share of GDP	2,901	22.34	9.54	4,921	23.55	8.54
Gini index	1,553	34.31	10.47	2,826	38.29	9.18
Terms of trade (net export price index)	4,065	111.75	74.24	5,267	74.61	26.43
Real effective exchange rate	2,910	151.04	133.60	3,754	100.99	37.34
Growth forecast	0	-	-	5,353	3.25	5.96

Note: See the main text for a description of the variables. I present the descriptive statistics for two equal-sized periods of time for simplicity, one capturing years 1960-1989 and the second capturing 1990-2019.

3.1 Local projections difference-in-differences (LP-DiD)

The LP method, originally proposed by Jordà (2005), has become a well-known and widely used approach in macroeconometrics to estimate impulse response functions[11]. Recent work by Dube et al. (2023) has advanced an estimator based on the seminal LP contribution specifically focused on correctly estimating panel data difference-in-differences models. The LP-DiD approach is particularly suited to address selection biases, which in our setting of the tariff-growth nexus are known to be relevant.

Dube et al. (2023) propose to use the flexible LP framework to to model explicitly the selection bias from pretrends (i.e., model pretrends through pretreatment covariates), formalizing in a sense the type of analysis performed by Acemoglu et al. (2019). Particularly, the LP-DiD specification proposed by Dube et al. (2023) consists on modelling this kind of selection bias through the inclusion of lags of first differences of the outcome variable (i.e., lags of growth rates here). By doing this, they show that biases coming from pretrends can be effectively eliminated[12]. The advantage of LP-DiD is essentially driven by its flexibility to control for pretreatment outcome dynamics, which is not straightforward in the traditional and recent DiD estimators. The authors provide Monte Carlo evidence showing that, in presence of this type of selection bias, the flexibility of LP-DiD proves to be superior addressing them in comparison to recent estimators like those by Callaway and Sant'Anna (2021) and Sun and Abraham (2021). In short, as a DiD estimator, the LP-DiD approach offers greater flexibility by relying on conditional no-anticipation and conditional parallel trends assumptions for identification, rather than unconditional ones.

The way the LP-DiD estimator deals with violations of the parallel trends assumption is not subject to biases after pretesting. On the contrary, the LP-DiD approach essentially

[11] One of the main appealing features of LP, as compared for example to VARs, is that, for realistic data generating processes, it provides less biased estimates, although at the cost of higher variance (D. Li, Plagborg-Møller, & Wolf, 2024).

[12] Another fundamental component of the LP-DiD estimator is to use sample restrictions, so that the control group of observations only includes what they call clean controls, to address the challenges identified by recent difference-in-differences literature. I develop this further in the robustness section.

amounts to tackle selection biases by exploiting covariates, as in Freyaldenhoven, Hansen, and Shapiro (2019). In other words, controlling for covariates is not subject to the biases of sample selection that arise after pretesting, as signaled by Roth (2022). As will be shown below, and has been demonstrated previously in the literature (Bohara & Kaempfer, 1991a, 1991b), tariffs are endogenous to GDP growth, which is interpreted as a proxy for self-interested political pressure. By controlling for pretreatment growth rates, the LP DiD estimator either controls directly for the source of endogeneity (as in Panel A in Figure 2 in Freyaldenhoven et al. (2019)), if we think that source is precisely previous growth dynamics, or controls as a proxy for the source of endogeneity (as in Panel C in Figure 2 in Freyaldenhoven et al. (2019)), if we think that source is political pressure.

3.2 Tariff reductions occur after fast GDP growth

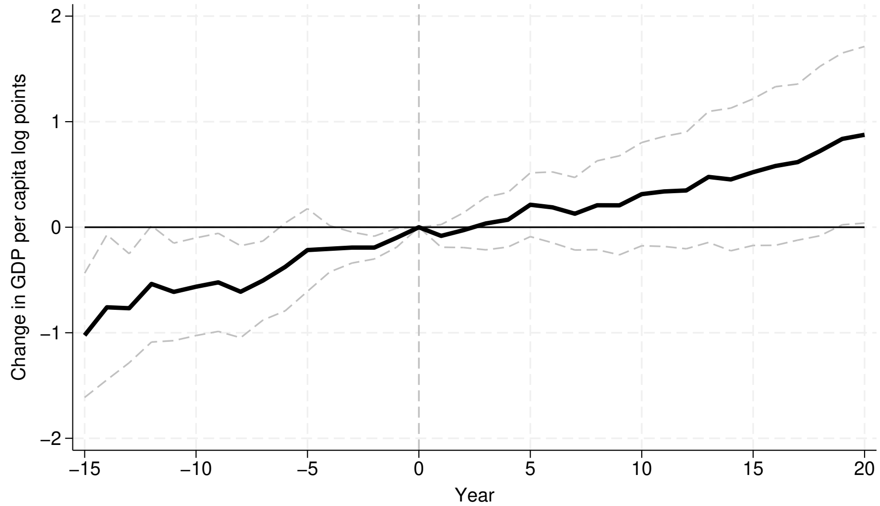
Are countries reducing tariffs on a different trajectory of GDP per capita than those not changing them? A simple LP equation to observe the evolution of (log) GDP per capita before and after a change in tariffs, based in Jordà (2005), is given by:

$$y_{c,t+h} - y_{c,t-1} = \beta_h \Delta TA_{c,t} + \alpha_t + \epsilon_{c,t} \tag{1}$$

where $y_{c,t+h}$ stands for (log) GDP per capita in country c in year $t+h$ and $\Delta TA_{c,t}$ refers to the change in the tariff level in year t with respect to year $t-1$, the variable of interest. To observe both the trajectory of GDP per capita before and after tariff changes, I estimate this regression equation separately for each $h = -15, -14, ..., 0, ..., 19, 20$. In other words, a local projection equation basically regresses the cumulative change in (log) GDP per capita in year $t+h$ against the change in tariffs at time t. The cumulative change in GDP per capita in $t+h$ related to a one-percentage-point increase in tariffs is β_h. Following Dube et al. (2023), I include only time fixed effects, as the equation is already in differences[13].

[13] I include country fixed effects later as a robustness check, and the heterogeneity holds.

Figure 1: GDP per capita before and after a one-standard-deviation tariff reduction



Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

A couple of comments regarding the presentation of results are in order, as they will apply for all results presented in the paper unless otherwise specified. Instead of presenting estimates associated to an increase in one percentage point in tariffs, I present the results associated with a decrease in one-standard-deviation of the change in tariffs, $SD(\Delta TA)$, a decrease in 3.65 percentage points. For example, in terms of equation 1, instead of plotting β_h I show $(-1) * SD(\Delta TA) * \beta_h$. And I also do the same for the heterogeneous results later shown. I do this for two reasons. First, most of the changes in tariffs in the data are decreases, consistent with the general trend towards liberal trade regimes in the last thirty years. Second, as shown in the Appendix in Figures A1 and A2, by separating the estimates of both increases and decreases, I find significant results only for tariff reductions. This means that the average correlations of tariffs presented in the paper are driven mainly by decreases in tariffs. I also present the results scaled to one-standard-deviation, so they have an order of magnitude related to the changes in tariffs observed in the data. And finally, I use two-way cluster robust standard errors, in the country and year dimensions, making the inference even more robust (Thompson, 2011; Cameron, Gelbach, & Miller, 2011).

The results associated with equation 1 are presented in Figure 1. As can be observed, countries reducing their tariffs are on a different GDP trajectory as compared to those not changing them. In particular, the former countries display a relative surge in GDP before tariff reductions as compared to the latter. In other words, tariff reductions are endogenous to the evolution of GDP, such that countries that decide to reduce tariffs do so after GDP has been on a relative increase, consistent with the findings by Bohara and Kaempfer (1991b). Failure to control for this surge constitutes a clear violation of the parallel trends assumption and may lead to biases in the dynamic estimates.

Thus, to deal with potential selection biases I model pretrends through lags of growth rates of GDP per capita, following the approach by Dube et al. (2023). Formally, the LP-DiD equation I estimate is:

$$y_{c,t+h} - y_{c,t-1} = \beta_h \Delta TA_{c,t} + \sum_{j=1}^{1,2,4,8} \sigma_h^j g_{c,t-j} + \alpha_t + \epsilon_{c,t} \tag{2}$$

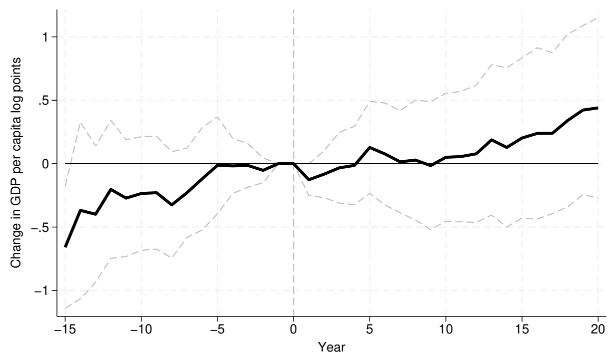
where, compared to equation 1, I include lags of the growth rate of GDP per capita to capture the surge in GDP preceding tariff reductions. The growth rate, $g_{c,t}$, is calculated simply as $y_{c,t} - y_{c,t-1}$. I use 1, 2, 4 or 8 lags of growth rates to test various alternatives to model effectively the surge in GDP.

The results of the estimates of equation 2 are presented in Figure 2. Only in the case with 8 lags am I able to obtain equal trajectories for countries reducing tariffs compared to those not changing them. In other words, conditional on 8 lags in growth rates, we are not able to reject the parallel trends assumption. More importantly, the associations after tariff reductions substantially change after addressing the selection bias. While Figure 1 shows that GDP significantly increases twenty years after tariff reductions, Figure 2, with 8 lags, addressing the selection bias, shows that the estimates are less than half in magnitude and no longer significant. Thus, from this point onward, I add 8 lags of growth rates to avoid the selection bias[14]. If the researcher were to stop at this point, tariff changes and growth

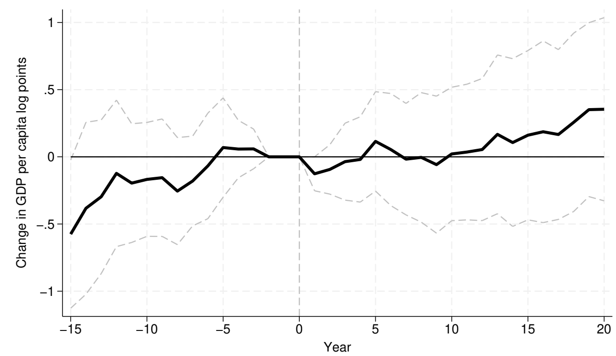
[14] In the Appendix, I show the results are robust to alternative lag structures to control for pretrends.

would appear to be uncorrelated, but that result would mask important heterogeneity, as I proceed to show below.

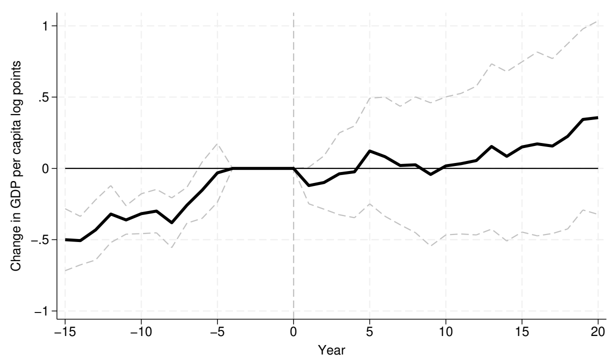
Figure 2: Modeling the surge in GDP per capita before tariff reductions through lags in growth rates



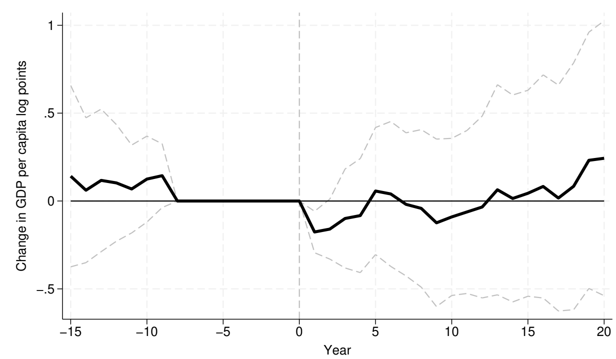
(a) 1 lag



(b) 2 lags



(c) 4 lags



(d) 8 lags

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

4 Baseline heterogeneity results

I now return to the main question of interest: does the tariff-growth nexus vary according to the economic structure of the countries? More precisely, is there suggestive evidence that trade liberalization may operate differently in manufacturer and nonmanufacturer countries?

To capture the heterogeneity in the relationship between tariffs and growth in relation to economic structures, I have to change the regression equation. I particularly explore the heterogeneity using an interaction term between tariff reductions and economic structure, or state-dependent local projections. Furthermore, to avoid compositional biases, I also introduce the economic structure as a variable (Cloyne, Jordà, & Taylor, 2023). The new LP-DiD equation is as follows:

$$y_{c,t+h} - y_{c,t-1} = \beta_h \Delta TA_{c,t} + \theta_h int_{c,t} + \phi_h m_{c,t} + \sum_{j=1}^{8} \sigma_h^j g_{c,t-j} + \alpha_t + \epsilon_{c,t} \tag{3}$$

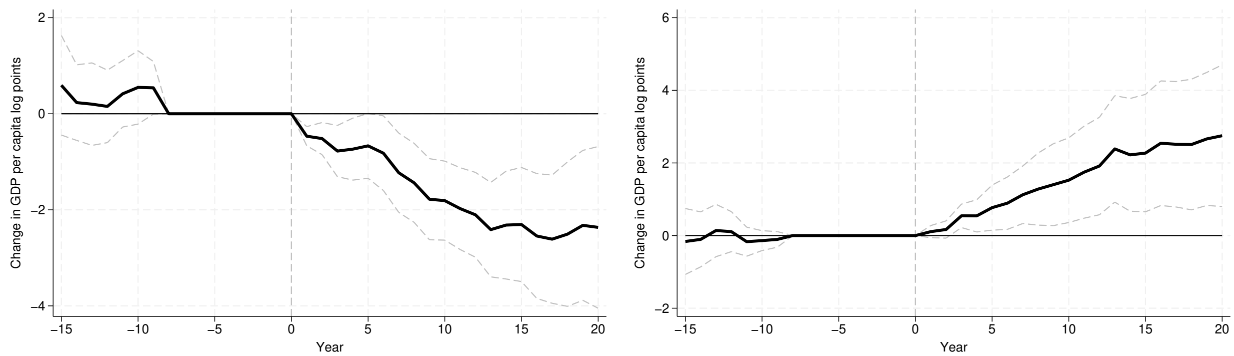
where $m_{c,t}$ represents economic structure and $int_{c,t}$ represents the interaction (multiplication) between changes in tariffs $\Delta TA_{c,t}$ and $m_{c,t}$. Economic structure, $m_{c,t}$, is calculated as the average of the share of manufacturing exports in the five years before tariff reductions, to avoid contemporaneous endogeneity that may run from GDP to manufacturing exports. With this specification, the association between tariff changes and growth varies with economic structure. For example, if I want to calculate the cumulative change in GDP per capita at time $t+h$ in relation to a one-standard-deviation tariff reduction for a country with an initial manufacturing share of exports of 29 percent, I estimate it by calculating $(-1) * SD\,(\Delta TA) * (\beta_h + 29 * \theta_h)$. To display the significance of the heterogeneity, I plot the estimates for the 10th and the 90th percentiles of economic structure. In other words, I present estimates associated with one-standard-deviation reduction in tariffs for a country with an initial share of manufacturing exports of 3.96 percent and a country with an initial share of 88.26 percent. From now on, I refer to the former estimates as those for nonmanufacturer countries and to the latter as the estimates for manufacturer countries[15].

Figure 3 reveals the results associated with equation 3, capturing the coefficients of tariff reductions for manufacturer and nonmanufacturer countries. For nonmanufacturer countries, the relation is negative, meaning that the liberalization of trade policy has been followed by a fall in GDP. For manufacturer countries, on the other hand, liberalizing their trade

[15] In Figures A3 and A4 in the Appendix, I show that for only two deciles—the 50th and 60th—I obtain results with no significant association.

regimes has been followed by higher GDP levels. Both subfigures also reveal no significant pretrends, which is reassuring of the specification iincluding 8 lags of growth rates to avoid the selection bias.

Figure 3: Heterogeneity in GDP per capita after tariff reductions



(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: The estimates presented are the predicted values for the 10th and 90th percentiles of the distribution of the share of manufacturing exports. The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

The heterogeneity of the tariff-growth nexus by economic structure is both statistically and economically meaningful. A one-standard-deviation reduction in tariffs is associated to an average decrease of 2.31 percent in GDP per capita after 15 years for nonmanufacturer countries. For manufacturer countries, in contrast, a one-standard-deviation decrease in tariffs is linked to an average increase in GDP after 15 years of approximately 2.32 percent. The change in GDP seems to stabilize after ten years, but the difference in levels persists even twenty years after tariff reductions. According to Estevadeordal and Taylor (2013), the median reduction in tariffs following the Washington Consensus of the 1990s was by 25 percentage points. Assuming a constant marginal relation, a 25-percentage-point reduction in tariffs would be linked to a fall in GDP per capita after 20 years of about 15.8 percent for nonmanufacturer countries. To illustrate how important these magnitudes are, the Norwegian economy grew by 15.9 percent between 2000 and 2019, virtually the same magnitude as the 20-year estimate that I obtain.

The baseline specification assumes that the heterogeneity by economic structure in the tariff-growth nexus is a linear function of the share of manufacturing exports. However, it could be the case that the previous results are the outcome of extrapolation from assumed functional forms. In the Appendix, instead of assuming linear heterogeneity, I divide the sample into tertiles (i.e., into three parts) according to the level of economic structure, and then estimate the tariff-growth nexus for each of them separately. I call this a nonlinear approach to heterogeneity. As shown in Figure A5, under this approach the tariff-growth nexus is negative for the first tertile but positive for the third one and in both cases with magnitudes essentially equivalent as those displayed in Figure 3.

Identification of the heterogeneity relies on one crucial identifying assumption. First, identification of β_h requires that tariff changes, conditional on the 8 lags of growth rates, are as good as random. Second, identification of θ_h does not require economic structure to be exogenous. Identification of interaction terms requires the source of heterogeneity, economic structure, and its source of endogeneity to be jointly independent from tariff reductions (Nizalova & Murtazashvili, 2016)[16]. Given that economic structure is not correlated with tariff reductions (p-value of 0.88), identification of the interaction term again boils down to the assumption of tariff reductions being as good as random, conditional on the 8 lags of growth rates. We know that, conditional on 8 lags of growth rates, countries reducing tariffs are not on a different trajectory ex-ante compared to countries not changing them. Nonetheless, in the next section, I will relax this identifying assumption through several robustness checks.

5 Robustness

In this section, I perform two sets of checks, aimed to test the robustness of the baseline results. The first set of checks is what I call sensitivity checks, aimed at exploring whether the

[16] Nonetheless, in the Appendix I perform an additional robustness check aimed to deal with potential endogeneity of economic structure.

results depend on specific baseline modeling choices. And the second set of checks is what I call relaxations to the baseline identifying assumption, aimed at exploring endogeneity concerns. All robustness checks confirm the existence of the heterogeneity by economic structure in the tariff-growth nexus.

I perform the sensitivity checks in three steps. First, I complete the LP-DiD analysis by performing a clean controls analysis through sample restriction, in the spirit of the DiD analysis by de Chaisemartin et al. (2024) for continuous treatments. The results prove that the heterogeneity is not driven by the problem of negative weights in DiDs (de Chaisemartin & d'Haultfoeuille, 2020; Goodman-Bacon, 2021). Second, I make use of three dynamic panel data estimators to show that the heterogeneity is not driven by the reliance on the LP-DiD estimator, and particularly the debiased Arellano-Bond through sample splitting (DAB-SS) by Chen et al. (2019). Finally, I carry out several other sensitivity checks, proving that the results are not driven by the baseline modeling choices of pretrends, the definition of economic structure, the GDP data source, and outlier observations.

I then relax my baseline identifying assumption in four steps, three shown in the main text and one only in the Appendix. I first control for covariates that have been demonstrated to matter for determining trade policy, such as growth expectations, import penetration and inequality as a proxy for political pressure. Second, I also control for other potential confounders and use more stringent sets of fixed effects to relax even more my identifying assumption. Third, to control for potential remaining time-varying confounders I use a local projections instrumental variable approach. Finally, in the Appendix, I conduct three more robustness checks to control for potential endogeneity threats from i) heterogeneity in the pretreatment-posttreatment growth correlation and heterogeneity in global shocks (i.e. year fixed effects), ii) future tariff changes, and iii) endogeneity of the economic structure.

5.1 Sensitivity checks

Clean controls analysis

Recent contributions have shown that standard DiD estimates based on two-way fixed effects regressions might be biased (de Chaisemartin & d'Haultfoeuille, 2020; Goodman-Bacon, 2021). The biases arise from using units as part of the control group that have been treated before, although they may not receive any treatment in the period of interest. In my baseline setting, the treatment group comprises observations with the largest changes in tariffs, in absolute value, while the control group is composed by country-year observations with lower changes. A country-year observation with a relatively low tariff change might be a "bad control" because that country might have experienced a high tariff change in previous years.

An approach to solving this issue in settings with treatments continuously distributed every time period has been recently proposed by de Chaisemartin et al. (2024), and I therefore follow it closely. The authors propose to use movers as treatment observations and quasi-stayers as control observations. A quasi-stayer is defined as an observation where changes in treatment intensity (i.e., tariff changes) are almost negligible, so that assuming treatment doesn't change is justifiable. It is actually easy to identify quasi-stayers in the tariff-growth setting. In most years since 1960, countries do not really change their average tariffs, but slight variation still appears in the data, even perhaps in some cases due to errors in the data collection process. Therefore, to differentiate between movers and quasi-stayers, I propose a definition for *relevant* tariff changes. A tariff change is *relevant* if it is one-standard-deviation separated from the mean tariff change[17].

The previous definition is not enough to circumvent the problem of "bad controls". For example, an observation of a country in 1995 with no *relevant* tariff change, a quasi-stayer, is still a "bad control" if that country experienced a *relevant* tariff change in 1990. Nevertheless,

[17] In Figures B2 and B3 in the Appendix, I verify the robustness of results to the use of different thresholds for defining *relevant* tariff changes, particularly half standard deviation and two standard deviations. The heterogeneity still holds.

what matters to get a "clean control" country-year observation is not that the country never experienced a *relevant* tariff change before, but that the dynamic treatment effect of that previous treatment has stabilized at the moment of the analysis (Dube et al., 2023). In other words, what matters is that the GDP associated to the *relevant* tariff change of 1990 stabilizes in a new level in 1995, and thus the quasi-stayer observation in 1995 is not in a differential trend as compared to the movers in that year. By observing Figure 3, it seems treatment effects stabilize approximately ten years after tariff reductions. Thus, I further assume that a quasi-stayer country-year observation can only be used as a control if the country has not experienced a *relevant* tariff change in the previous ten years, what I call the ten-year rule[18].

I thus implement a clean controls analysis following de Chaisemartin et al. (2024) by relying on the definition of movers and quasi-stayers based on *relevant* tariff changes and on the ten-year rule. In practice, that simply means estimating the LP-DiD specification from equation 3 but only including both mover and quasi-stayer observations that satisfy the ten-year rule. Results are shown in Figure B1. For nonmanufacturers, reducing tariffs is still negatively associated to GDP in the whole period and significant for almost all of it. For manufacturers, on the other hand, the association is still positive and significant from 10 to 17 years after tariff reductions.

Dynamic panel estimators

A potential concern might be that the results are driven by the use of the LP-DiD estimator. To explore this possibility, I provide dynamic panel estimates, following the application by Acemoglu et al. (2019). To avoid inference problems related to stationarity in a dynamic panel setting, I run a regression of the relation between tariff changes and growth rates. Contrary to the LP-DiD regressions, which estimate the dynamic effect for each time horizon,

[18] In Figure B4 in the Appendix, I relax this assumption, by imposing that a quasi-stayer can only be part of the control group if the unit was not treated in the previous twenty years. Results still deliver the heterogeneity, but significance is only preserved for the case of nonmanufacturer countries.

the regression equation for dynamic panel data estimates is based on a single-equation regression as follows:

$$\Delta y_{c,t} = \beta \Delta TA_{c,t} + \theta int_{c,t} + \phi m_{c,t} + \sum_{j=1}^{8} \sigma_j \Delta y_{c,t-j} + \alpha_c + \alpha_t + \epsilon_{c,t} \tag{4}$$

where coefficients do not depend anymore on the horizon time h.

I present estimates of equation 4 coming from three types of estimators: the within fixed effects, the difference-GMM by Arellano and Bond (1991), and the recent debiased Arellano-Bond through sample splitting (DAB-SS) by Chen et al. (2019). I first perform a within fixed effects panel data estimation as a reference. Then, I perform a difference-GMM Arellano-Bond estimation, which addresses the well-known Nickell bias of the within fixed effects estimates. Finally, following Chen et al. (2019), I also provide estimates using their proposed debiased Arellano-Bond estimator through sample splitting. The difference-GMM estimator has the problem of "too many instruments", that leads to an asymptotic bias when T is at least modestly large (Alvarez & Arellano, 2003). To deal with this problem, Chen et al. (2019) show that by splitting the sample in two parts, dividing along the cross section, this method delivers consistent and unbiased coefficients when both N and T are large.

Results are presented in Table B1. The estimates exhibit little persistence, thus confirming that the specification used may not be affected by near–unit root issues. Consistent with the baseline results, the coefficient on the interaction is significant in all specifications and positive as expected, meaning that the marginal association between reducing tariffs and growth rates is higher for manufacturers than for nonmanufacturers.

Other modeling choices

I conduct three additional sensitivity checks. First, I check if the results are driven by the specific modeling choice of the selection bias through 8 lags of growth rates. To do so, I first check pretrends for manufacturers and nonmanufacturers separately, and then I change the number of lags to test the robustness of the results. Second, I vary the definition of economic structure. Among these alternative definitions, I use the share of manufacturing exports in 1962, which might reduce endogeneity concerns regarding this variable for most tariff changes in the sampe which are post-1990, and revealed comparative advantage in manufacturing, as it resembles more closely the theory guiding the empirical exercise. And finally, I check use alternative GDP data sources and conduct analyses to deal with outlier observations. Reassuringly, the heterogeneity is robust to all these modeling choices.

5.2 Relaxations of the baseline identifying assumption

This subsection is developed in three steps, as mentioned. The first one discusses drivers of trade policy and controls for them, and the second does the same for other potential confounders as well as including an extremely stringent set of fixed effects to relax endogeneity concerns even more. Results for these two sets of exercises are shown through the summary Figure B24, where I plot the average effect for manufacturers and nonmanufacturers between 13 to 17 years after tariff reductions. Specifically, to control for the covariates I run my local projections for each of them in turn, including 4 lags of their first differences, as in Acemoglu et al. (2019). These specifications have to be interpreted with caution, since changes in these covariates may be endogenous to tariff changes, although using lags may relax this concern. In the Appendix I also display individual impulse response graphs for each of the robustness exercises estimated. I finish the section presenting instrumental variable estimates, adapting the variable by Furceri et al. (2022) for my enquiry of heterogeneity by economic structure.

Endogenous trade policy

In this subsection I show robustness checks related to variables identified as drivers of tariffs, coming from the endogenous trade policy literature (Mayer, 1984; Grossman & Helpman, 1994). Three factors are salient in the empirical endogenous trade policy literature. The first factor identified to explain trade policy changes empirically was GDP growth (Bohara & Kaempfer, 1991b). The second factor identified was distribution, as it has been shown that higher inequality leads to higher trade protection in capital-abundant countries (arguably manufacturer countries) while lower protection in capital-scarce countries (arguably nonmanufacturer countries) (Dutt & Mitra, 2002). And finally, Trefler (1993) shows that tariffs are also explained by import penetration.

First, although the baseline framework already incorporates lags in growth rates, it might be that expectations on contemporaneous growth are what really drives tariff changes. To control for this possibility, I use growth forecast data from the World Economic Outlook of the IMF. Specifically, I calculate the change in the growth forecast for year t made in $t-1$ with respect to the growth forecast made in $t-2$. Robustness exercise number 1 in Figure B24 summarizes the results of including the change in growth forecasts in the baseline specification[19].

Second, to control for the potential endogeneity of tariff changes arising from distribution itself, I use the Gini coefficient from the Standardized World Income Inequality Database (Solt, 2020). The results are presented in robustness exercise number 2 in Figure B24. And third, to control for endogeneity that may arise from import penetration, I use the share of imports in GDP from the World Bank. The results are presented in robustness exercise number 3 in Figure B24. The identified heterogeneity holds in both cases.

[19] It is important to note that, only for this covariate, I control for it in a different way than including 4 lags of first differences, given the nature of the forecast.

Other confounders

I perform robustness checks on other potential confounders in the tariff-growth nexus in four steps. First, I show robustness checks with respect to other policy changes that might be associated to changes in tariffs. Second, I show the robustness of the results to consideration of economic phenomena that have been found to be important for explaining growth. Third, I investigate the robustness of the heterogeneity to other possible heterogeneous relations in the tariff-growth nexus. Finally, I investigate the robustness of the baseline results to different trends in GDP among groups of countries.

Tariff changes are usually decided in settings where countries are also changing other types of policies. For instance, the trade liberalization of the 1990s was part of a broad set of market reforms aimed at liberalizing economies generally (Williamson, 1990). Thus, the baseline estimates can potentially be driven by other policy changes, and checking the robustness to those changes becomes necessary. I thus control for changes in nontariff barriers, changes in capital account openness, and changes in institutional quality. The results are presented in robustness exercises number 4, 5 and 6, respectively, in Figure B24. The heterogeneity remains similar to that in the baseline results.

Another threat to the validity of the baseline results could come from covariates proven to affect GDP that might be correlated with tariff changes. I particularly control for changes in human capital, population size, trade openness, gross fixed capital accumulation, exchange rates, and terms of trade. Results for all these checks are presented in robustness exercises 7, 8, 9, 10, 11 and 12, respectively, in Figure B24. The heterogeneity is still significant.

Next, there might be other relevant heterogeneities at play in the tariff-growth nexus that might make the baseline estimates biased. First, some theoretical work discuss that distance to the frontier seems to be the relevant source of heterogeneity (Acemoglu, Aghion, & Zilibotti, 2006), which might be more adequately captured by initial income. Second, according to Lucas (1988), heterogeneous effects might be the outcome of trade opening if sectors differ in their potential for human capital accumulation. Robustness results for the heterogeneity by economic structure, controlling for each of these heterogeneities in turn, are presented in exercises number 13 and 14, in Figure B24. The heterogeneity holds.

Finally, I use extremely stringent fixed effects to further relax endogeneity concerns. First, I add country fixed effects, which in our specification in differences end up capturing trends by country following tariff reductions. In other words, I remove the average GDP trend over the years by country, an extremely demanding exercise that might be capturing part of the effect of interest. Then, I test the robustness of the results to the inclusion of calendar time trends by income groups of countries, and regional groups of countries. Calendar time trends imply that I remove variation in average trajectories specific to given years for these groups of countries. In other words, I remove trends for Latin American countries after 2000, but also remove these trends for 2001, 2002, as well as all years in the sample. Reassuringly, the heterogeneity is robust to all these checks, as shown in robustness exercises 15, 16 and 17 respectively, in Figure B24.

Instrumental variable

Endogeneity concerns to time-varying unobservables might remain. To address them, I use a local projections instrumental variable approach (Stock & Watson, 2018).

To instrument tariff changes, I use a weighted average of tariff changes of the 5 largest trading partners of each country in each year. This instrument was proposed and used by Furceri et al. (2022), and follows the spirit of the instrumental variable approach by Acemoglu et al. (2019). The authors particularly show that i) the instrument is not significantly correlated with the residuals of regressions of income in terms of tariff changes, and ii) in those same regressions the instrument has no significant effect when added as another explanatory variable. These two tests arguably suggest that tariff changes in major trading partners do not have any effect on domestic macro variables other than through domestic tariff changes, pointing to the validity of the instrument[20].

In practical terms, as documented in the Appendix, I first obtain tariff changes as predicted by the instrument. The first stage F statistic is of 17.4, so that concerns regarding weak instruments inference seems to be absent. Then, I use these predicted tariff changes and their interaction with economic structure as explanatory variables in the second stage, to get the heterogeneity estimates, just as before. In order to get standard errors that take into account the sampling uncertainty of the first sage into the second, and more generally to make the inference more adequate for instrumental variables estimates (Young, 2022), I use bootstrapping clustered at the country level.

Figure B45 shows the results of the local projections instrumental variables approach. Once again, the heterogeneity holds. GDP increases for manufacturers following tariff reductions, and the effect is significant from 3 to 16 years after tariff reductions. For nonmanufacturers, GDP falls following tariff reductions, with significant effects particularly 3 to 6 years after reductions. More importantly, the interaction term capturing the heterogeneity is significant in the majority of periods after tariff reductions, meaning that even when the effects are not significantly different than zero for nonmanufacturers the difference between them and the effects for manufacturers is significant. The effect sizes for both type of countries is much bigger, as also found by Furceri et al. (2022), which may suggest that the effects of tariff changes driven by retaliation could have bigger effects in absolute value than changes due to other motives.

6 Mechanisms

In this section, I test the potential validity of the mechanisms from theory that may explain the heterogeneity in the tariff-growth nexus by economic structure. I particularly explore the association between tariff reductions and four variables: i) productivity, ii) capital

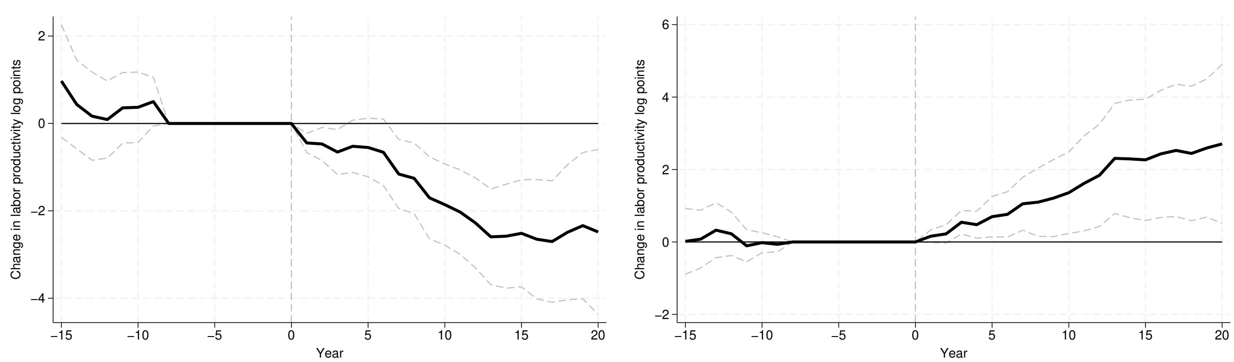
[20]I thank Swarnali Hannan for sharing with me the instrument data.

accumulation, iii) manufacturing share of GDP, and iv) share of imports in GDP. I use the following specification to analyze these potential channels:

$$y_{c,t+h} - y_{c,t-1} = \beta^h \Delta TA_{c,t} + \theta^h int_{c,t} + \phi^h m_{c,t} + \sum_{j=1}^{8} \sigma_j^h g_{c,t-j} + \sum_{j=1}^{8} \gamma_j^h \Delta y_{c,t-j} + \alpha_t^h + \epsilon_{c,t}^h \quad (5)$$

where, unlike in the baseline specification, $y_{c,t}$ refers to one of the four variables explored, so the specification also includes eight lags of the first difference in each of them. The regression retains the lags in GDP growth rates and time fixed effects from the baseline regression. I once again graph the estimates of a one-standard-deviation reduction in tariffs for nonmanufacturers and manufacturers.

Figure 4: Heterogeneity in labor productivity after tariff reductions



(a) Nonmanufacturer countries **(b)** Manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

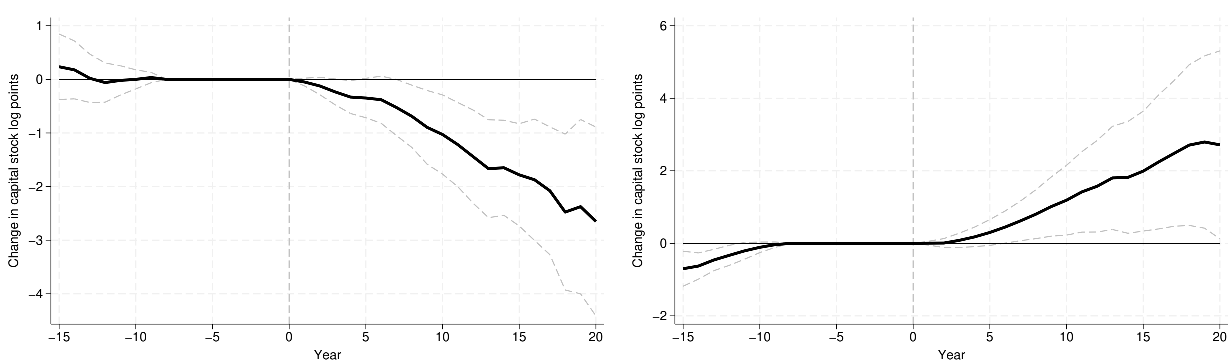
Tariff reductions are associated with lower productivity in non-manufacturer countries and higher productivity in manufacturer countries, as shown in Figure 4[21]. According to the trade theory reviewed, that's precisely the heterogeneity expected in productivity terms. More specifically, reducing tariffs lead nonmanufacturer countries to specialize in the less

[21] In Figure C1, I also show estimates of total factor productivity (TFP) dynamics after tariff reductions. The results point to the same heterogeneity for all the horizon of analysis but only significant around 15 years after tariff reductions.

dynamic sector, abandoning production in the more dynamic sector, so that productivity at the aggregate level ends up falling. Similarly, reducing tariffs may increase productivity and growth in manufacturer countries, as it allows for increased specialization in the more dynamic sector. The results on productivity are also statistically significant for the entire horizon of analysis and economically meaningful (i.e., more than a 2 percent reduction in productivity as a result of a one-standard-deviation decrease in tariffs for nonmanufacturers).

As portrayed in Figure 5, the dynamics of capital accumulation after tariff reductions are also heterogeneous: capital stocks fall for non-manufacturer countries while they increase for manufacturers. Results are also statistically significant for all the horizon of analysis. In the same line as the previous results, as production in the more dynamic sector falls (increases) in nonmanufacturer (manufacturer) countries, capital accumulation might also fall (increase), assuming that the dynamic sector is more capital intensive than the average of the economy. One can also make sense of these results as they relate to the idea that capital accumulation moves in the same direction as productivity, as demonstrated extensively by the development accounting literature (Klenow & Rodriguez-Clare, 1997; Hsieh & Klenow, 2010)[22].

Figure 5: Heterogeneity in capital accumulation after tariff reductions



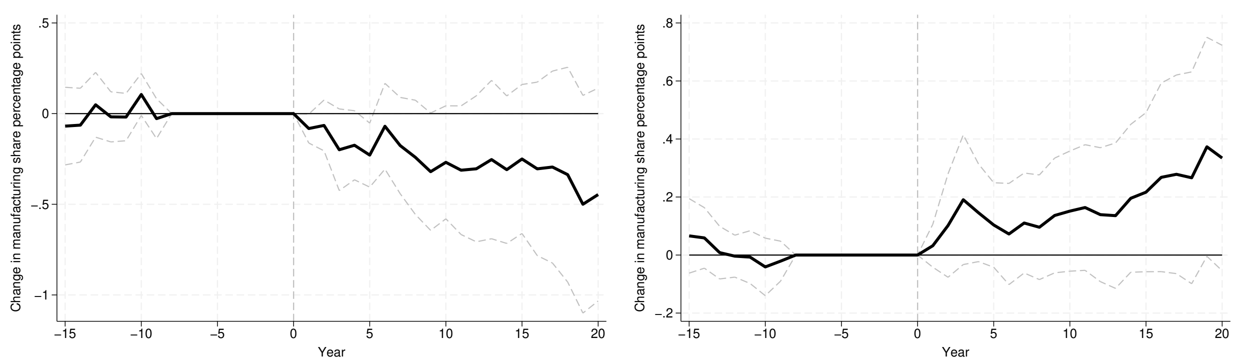
(a) Nonmanufacturer countries **(b)** Manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

[22]The effects on capital accumulation in this literature come from TFP changes, not labor productivity ones, which anyways is consistent with the results shown in Figure C1.

As mentioned, the heterogeneity is, in theory, ultimately driven by changes in the pattern of production specialization for each type of country. Figure 6 presents suggestive evidence of this mechanism. Tariff reductions are associated to lower manufacturing shares of GDP for nonmanufacturer countries, but higher for manufacturer countries. Although the results are not significant, the direction is consistent with the observed heterogeneity across the entire horizon of analysis. These results suggest that tariff reductions lead nonmanufacturer countries to specialize more in non-manufacturing production, while manufacturer countries strengthen their manufacturing specialization[23]. This re-specialization mechanism can also be considered the driver of the heterogeneous changes in both productivity and capital accumulation.

Figure 6: Heterogeneity in the manufacturing share of GDP after tariff reductions



(a) Nonmanufacturer countries **(b)** Manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

The heterogeneous relation between tariff reductions and manufacturing shares of GDP also relate to other strands of the literature on macroeconomics of development. First, according to Rodrik (2016) developing economies have experienced premature reductions in their manufacturing shares of GDP in the last thirty years, arguably driven by globalization. The evidence presented here for nonmanufacturer countries might support this argument.

[23] Although manufacturing shares of GDP provide a good proxy, the ideal data to test the relocation mechanism are manufacturing shares of employment. Cross-country data on sectoral shares of employment is however scant, compared to the data used here.

Second, the evidence suggests manufacturing is the more dynamic sector in the economy, as analytically considered in theory. In that sense, the evidence might also be in line with that presented by Rodrik (2013), according to which manufacturing is different to all other broad economic sectors in that it is characterized by unconditional convergence at the cross-country level.

Finally, I also explore the dynamics of the share of imports in GDP after tariff reductions, as revealed in Figure C2. Results reveal that the share of imports in GDP does not significantly change after tariff reductions, for both nonmanufacturer and manufacturer countries. A priori, an increase in the share of imports is expected for both types of countries, given that imports become cheaper for both. The relocation mechanism discussed above might help explain why this is not what we observe. As nonmanufacturer countries deindustrialize, import demand for intermediate and capital goods might also fall, given that the manufacturing sector is more reliant on them. Even though imports of these types of goods are now cheaper, the volume imported may still decrease. For manufacturer countries, on the other hand, the strengthening of the manufacturing sector might lead to a reduction in the import elasticity of demand. Thus, even though imports of manufacturing goods are now cheaper, the volume imported may not increase. Nevertheless, more work is needed to test the validity of these reasonings.

7 Conclusion

In this paper, I establish that the relationship between tariffs and growth is characterized by a sharp heterogeneity by economic structure. More precisely, I show that the reduction in tariffs around the world since 1960, particularly strong in the last 30 years, has been associated with reductions in GDP per capita for nonmanufacturer countries, but increases in GDP per capita for manufacturers. I establish this result by using a local projections difference-in-differences (LP-DiD) estimator, which allows me to study medium-term dynamics of the tariff-growth nexus and also control for the surge in GDP that precedes tariff reductions, thereby purging the estimates of this selection bias. Overall, the estimates suggest that a one-standard-deviation reduction in tariffs (i.e., 3.65 percentage points) is associated with an average fall (increase) of more than 2 percent in GDP per capita fifteen years later for nonmanufacturer (manufacturer) countries. The heterogeneity is significant even twenty years after tariff reductions and is confirmed by an extensive battery of robustness checks.

I further present evidence on potential channels underpinning this heterogeneity that are consistent with the trade theory that motivates the investigation. On the one hand, tariff reductions are associated with lower productivity and capital accumulation for nonmanufacturer countries. On the other hand, tariff reductions are accompanied by higher productivity and capital accumulation for manufacturer countries. I also show that both these changes and those on GDP might at the end be related to changes in the manufacturing share in GDP, although results are not statistically significant. This evidence can be interpreted as supporting Rodrik (2016)'s account of premature deindustrialization, according to which most Latin American and African countries have experienced early reductions—in relation to their level of development—in their manufacturing shares of GDP due to globalization in the last 30 years.

While this paper does not provide a definitive conclusion on the association between tariffs and growth, I believe it offers an invitation to continue reflecting on it. On the one hand, the findings suggest that liberalization has been beneficial for manufacturer countries, including the United States, Europe, and even China in more recent decades. As such, the recent rise in protectionism in these countries could end up being harmful to them. On the other hand, the evidence also suggests that for nonmanufacturer countries, arguably most Latin American and African ones, trade liberalization has been associated with lower GDP. Therefore, the paper also suggests that policymakers' calls for further trade liberalization in those regions could have unintended negative effects.

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Online appendix

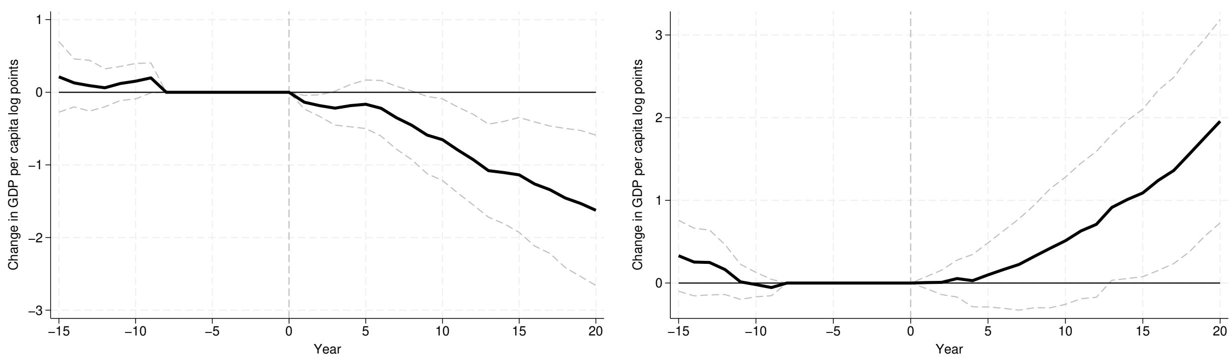
The Appendix contains three sections, each one corresponding to one in the main text. The first one refers to the baseline results section, the second to robustness, and the third to mechanisms.

A Baseline heterogeneity results

Increases and reductions of tariffs

The following two graphs present the average results associated to reductions of tariffs, on the one hand, and increases, on the other.

Figure A1: Heterogeneity in GDP per capita after tariff reductions: excluding tariff increases



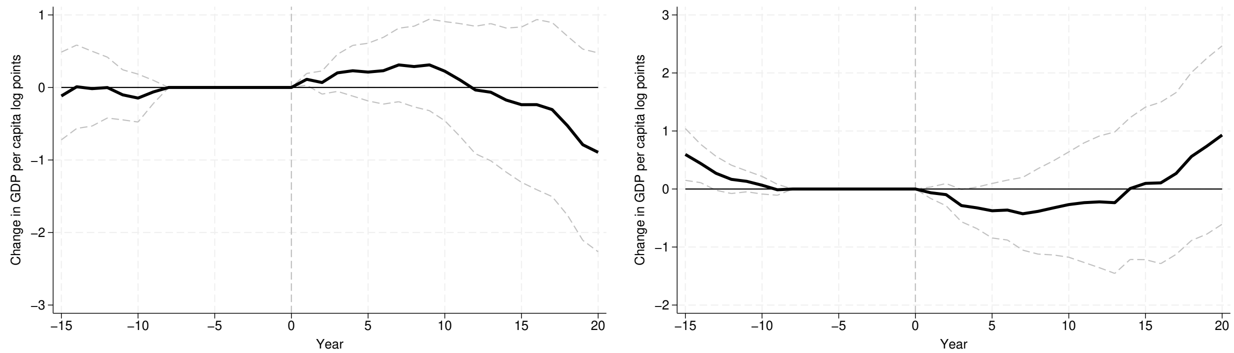
(a) For nonmanufacturer countries

(b) For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

As it can be observed in Figure A1, tariff reductions are associated with GDP falls for nonmanufacturer countries and GDP increases for manufacturer countries. On the other hand, the estimates of tariff increases, show in Figure A2, are not significant across the whole period for both type of countries.

Figure A2: Heterogeneity in GDP per capita after tariff increases: excluding reductions



(a) For nonmanufacturer countries

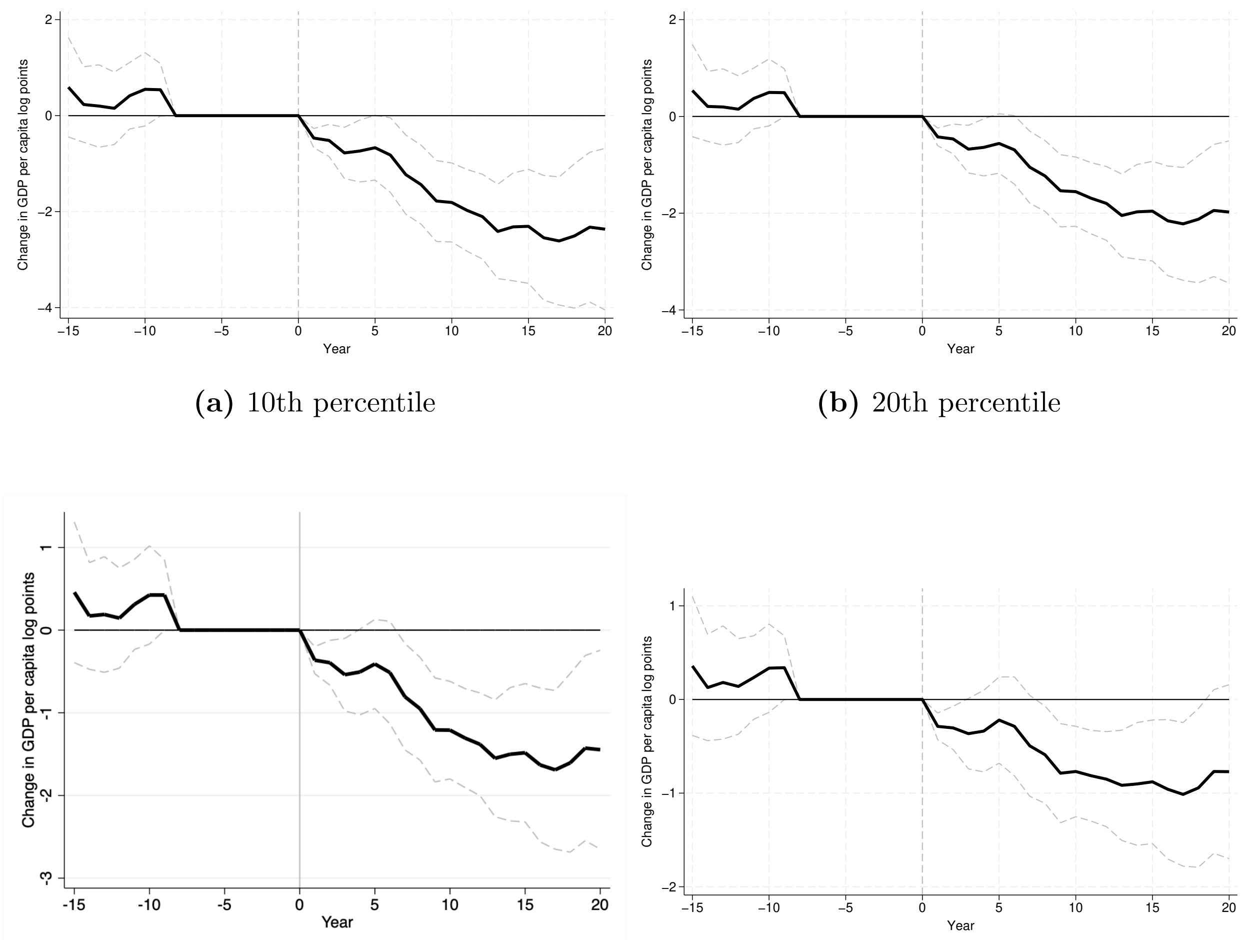
(b) For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

The tariff-growth nexus at different levels of initial economic structure

In the main text, I present the results associated to tariff reductions for countries with two different levels of initial shares of manufacturing exports—what can be called manufacturer and nonmanufacturer countries. Here I show the results for different levels of manufacturing exports, given the linear specification of heterogeneity in equation 3.

Figure A3: Heterogeneity in GDP per capita after tariff reductions: different levels of economic structure, part 1



(a) 10th percentile

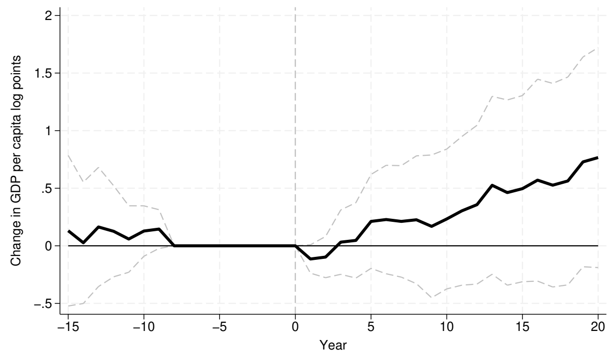
(b) 20th percentile

(c) 30th percentile

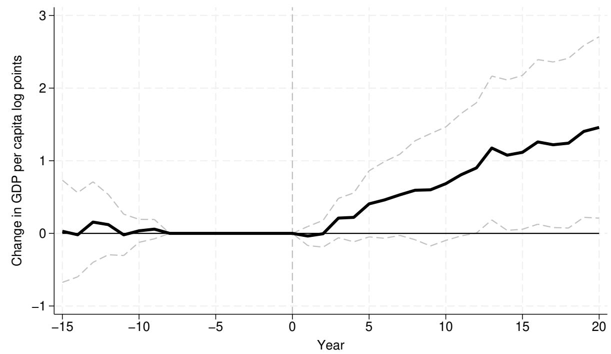
(d) 40th percentile

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

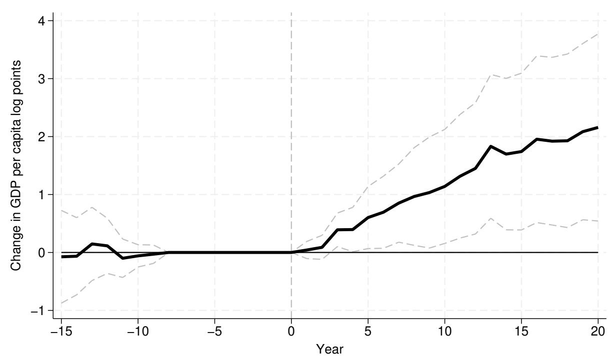
Figure A4: Heterogeneity in GDP per capita after tariff reductions: different levels of economic structure, part 2



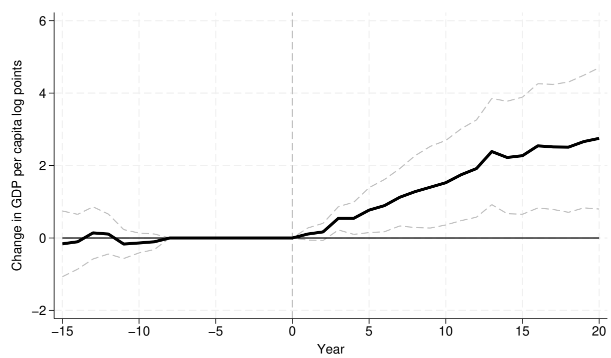
(a) 60th percentile



(b) 70th percentile



(c) 80th percentile



(d) 90th percentile

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

Figures A3 and A4 show that at least for the top 30 percent of the distribution of manufacturing exports, there is a positive relation between GDP and tariff reductions, while for the bottom 40 percent of the distribution, the relation is negative.

Nonlinear heterogeneity

Throughout the paper, I have used the specification of heterogeneity of tariffs on growth from equation 3. However, this specification is premised on one important assumption that needs to be examined. The baseline specification assumes that the heterogeneity by economic structure in the tariff-growth nexus is a linear function of the share of manufacturing exports, but this is not guaranteed a priori. In other words, it could be the case that the baseline results are the outcome of extrapolation from assumed functional forms. To test for a nonlinear relationship, I change the regression specification by introducing dummies for tertiles of observations according to their economic structure and the interactions between these dummies and the change in tariffs. The new equation is as follows:

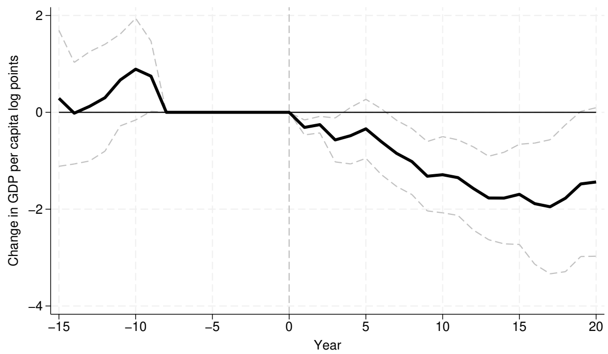
$$y_{c,t+h} - y_{c,t-1} = \beta_h \Delta TA_{c,t} + \sum_{k=1}^{3} \theta_h^k intd_{c,t}^k + \sum_{k=1}^{3} \phi_h^k md_{c,t}^k + \sum_{j=1}^{8} \sigma_h^j g_{c,t-j} + \alpha_t + \epsilon_{c,t} \qquad (6)$$

where k now refers to tertiles of manufacturing exports, so that $k = 1$ refers to observations in the bottom 33.3 percent of that variable. Also, $md_{c,t}^k$ refers to the manufacturing dummy taking value 1 if the observation belongs to the tertiles k or zero otherwise. Finally, $intd_{c,t}^k$ represents the interaction between $\Delta TA_{c,t}$ and the dummy just explained, $md_{c,t}^k$. Thus, to calculate the one-standard-deviation decrease relation for each of the tertiles of the distribution of manufacturing exports, I estimate $(-1) * SD\,(\Delta TA) * \left(\beta_h + \theta_h^k\right)$.

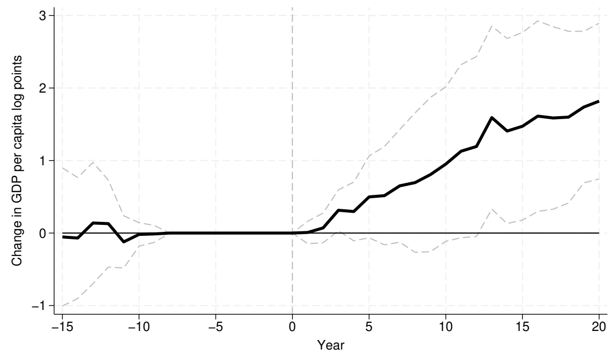
The results associated to the bottom ($k = 1$) and top ($k = 3$) tertiles of estimating equation 6 are shown in Figure A5. For the first tertile of manufacturing exports, GDP per capita is lower in all the 20 years after tariff reductions, and significantly so for almost all of them. For the third tertile, the estimates are aalways positive and significant after the eleventh year following tariff reductions. Overall, the results with this specification are reassuring that there is indeed heterogeneity in the relationship between tariffs and GDP per capita based on economic structure, and that this relationship is not the outcome of the linear heterogeneity assumption in the baseline results[24].

[24] I do not show the result for the second tertile to keep the presentation simple, but it is close to zero in all periods, consistent with the heterogeneity story.

Figure A5: Heterogeneity in GDP per capita after tariff reductions: top and bottom tertiles of economic structure



(a) For nonmanufacturer countries



(b) For manufacturer countries

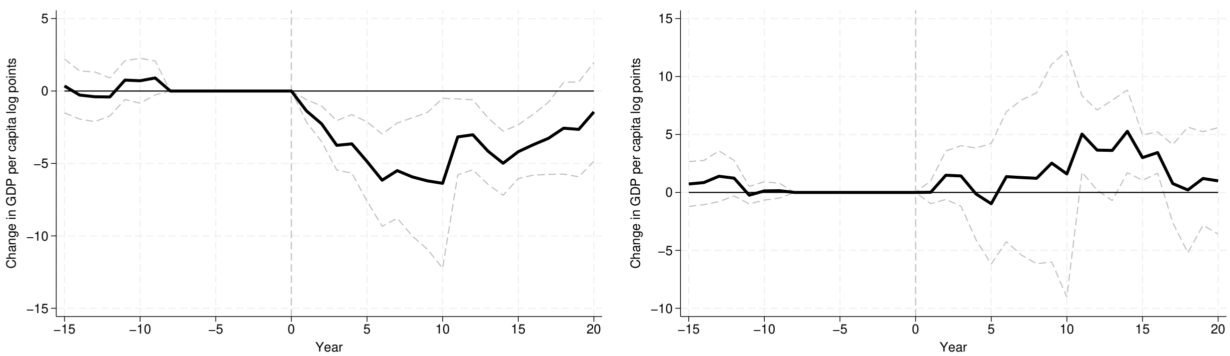
Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

B Robustness

Clean controls analysis

I present here the tables associated with the clean control analysis, as referred in the main text.

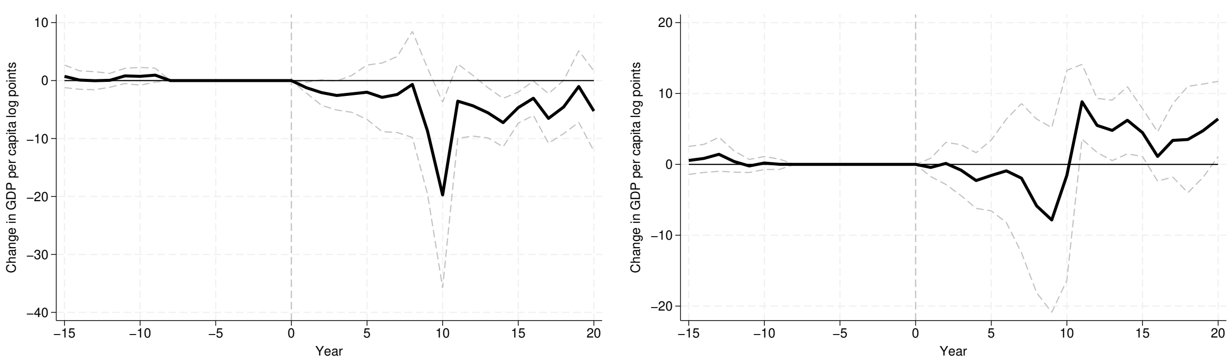
Figure B1: Heterogeneity in GDP per capita after tariff reductions: clean controls analysis



(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

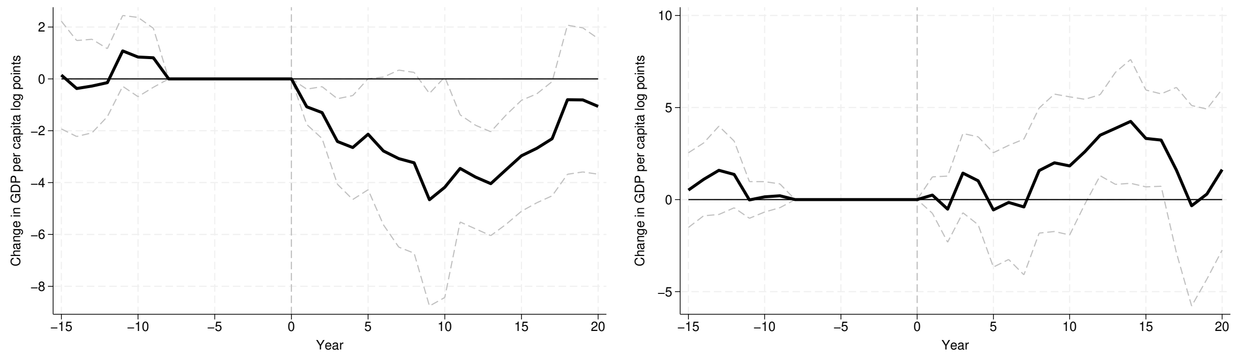
Figure B2: Heterogeneity in GDP per capita after tariff reductions: clean controls analysis with threshold defined as half standard deviation from the mean tariff change



(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

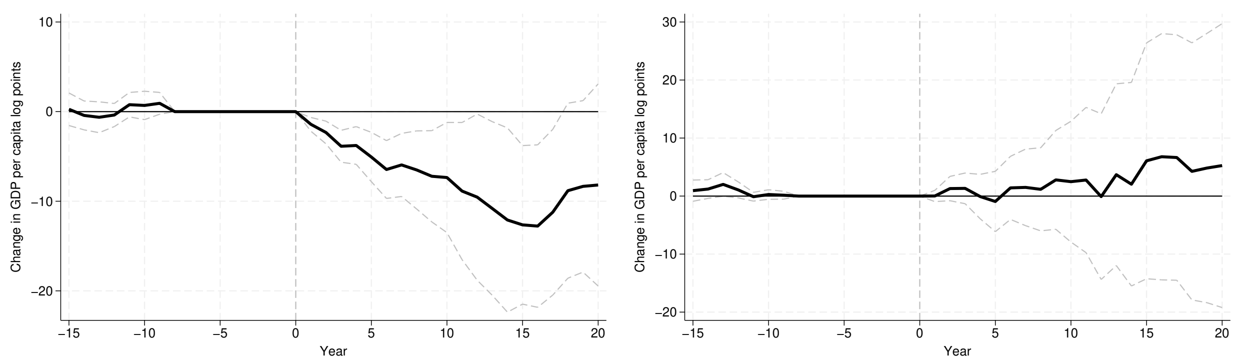
Figure B3: Heterogeneity in GDP per capita after tariff reductions: clean controls analysis with threshold defined as two standard deviation from the mean tariff change



(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

Figure B4: Heterogeneity in GDP per capita after tariff reductions: clean controls analysis with a twenty-year rule for quasi-stayers



(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

Dynamic panel estimators

Table B1 presents the results of the heterogeneity using dynamic panel estimators, as explained in the main text.

Table B1: Heterogeneity in growth rates after tariff reductions: dynamic panel estimates

	Within	Diff-GMM	DAB-SS
	(1)	(2)	(3)
Δ tariffs	-0.423***	-0.440***	-0.423***
	(0.136)	(0.135)	(0.027)
Initial share of man. exports	0.004	0.011	0.013***
	(0.007)	(0.009)	(0.001)
Interaction	0.005**	0.005**	0.006***
	(0.002)	(0.002)	(0.001)
Growth persistence	0.270***	0.213***	0.209***
	(0.050)	(0.051)	(0.008)
Impact for nonmanufacturers	-0.402***	-0.410***	-0.416***
	(0.128)	(0.127)	(0.026)
Impact for manufacturers	0.048	0.042	0.074*
	(0.118)	(0.119)	(0.043)
Observations	4,209	3,973	3,973
Countries in sample	161	161	161

Note: *p<0.1; **p<0.05; ***p<0.01. This table present estimates results of equation 4, scaled to one standard deviation reduction in tariffs. All specifications control for country and year fixed effects, and 8 lags of growth rates. The standard errors reported in parenthesis are robust to heteroskedasticity and serial correlation at the country level. Standard errors in the DAB-SS estimator are based on 100 bootstrap repetitions.

Other modeling choices

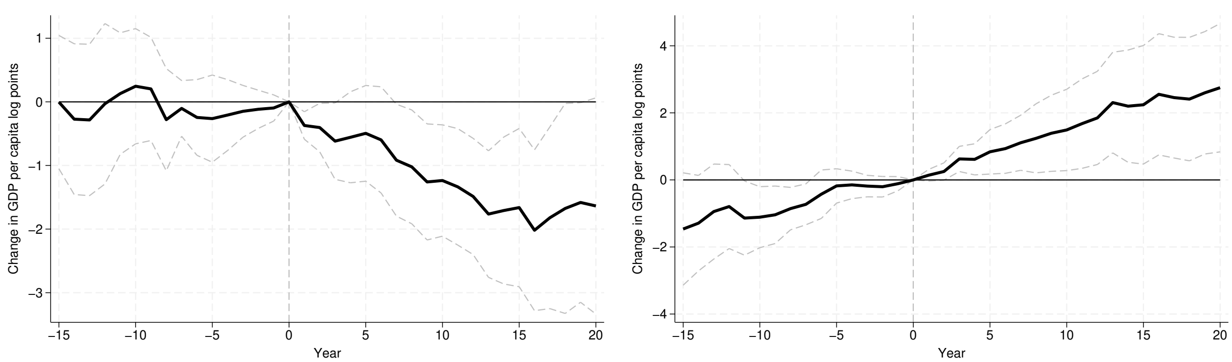
Alternative modeling of pretrends

The underlying identification assumption of the baseline results is that, conditional on eight lags of growth rates, tariff reductions are as good as random. However, given that the main focus of the empirical exercise is to establish the existence of heterogeneity in the tariff-growth nexus by economic structure, the crucial aspect becomes that countries reducing tariffs are not in a different trajectory before reducing tariffs as compared to countries not changing them in each of the groups, nonmanufacturers and manufacturers. In the same way, to potentially accommodate differential pretrends between manufacturers and nonmanufacturers and also relax the assumption based on eight lags it becomes important to check the sensitivity of the results to alternative lag structures.

I first check pretrends for each group by presenting heterogeneity results from estimating equation 3 without lags. Results are presented in Figure B5. The pretrends analyzed in Figure 1, according to which tariff reductions are preceded by a surge in GDP, only hold for manufacturers. In other words, while nonmanufacturers reducing tariffs seem not to be in a different trend compared to nonmanufacturers not changing them, manufacturers do experience a significant increase in GDP before reducing tariffs as compared to manufacturers not changing them. Nevertheless, it is good to remind that the statistical power for pretrends testing is low (Roth, 2022), so that even for nonmanufacturers there might be a violation of the parallel trends assumption although not captured empirically. Apart from the pretrends analysis, the Figure still shows a significant association between tariff reductions and GDP per capita, positive for manufacturers and negative for nonmanufacturers. In other words, the significant heterogeneity documented in the paper holds even when I do not include eight lags of growth rates.

I then relax the assumption of the baseline specification related to modelling the selection bias through eight lags of growth rates. Figures B6 and B7 show the results when I include one lag, two lags, four lags and six lags, instead of eight as in the baseline equation 3. As before, significant pretrends only emerge for the case of manufacturer countries. A crucial difference of this heterogeneity analysis of pretrends is that the pretrends for manufacturers are significant even in the case of one or two lags, contrary to the homogeneous average case depicted in Figure 2. In fact, even when we include six lags, although pretrends become insignificant, a visible positive pretrend for manufacturers still exists. By looking again at Figure 2, compared to these ones, it becomes evident that only when I include eight lags the pretrend stop being clearly positive. Given that pretrends testing may not be enough to cure estimates from biases emerging from violations of parallel trends (Roth, 2022), the specification with eight lags is much better to address potential biases from pretrends as it really captures the pretrend (beyond significance). Nonetheless, it is reassuring to find that the heterogeneity documented in the paper is not driven by the specific lag structure adopted to model the pretrends biases.

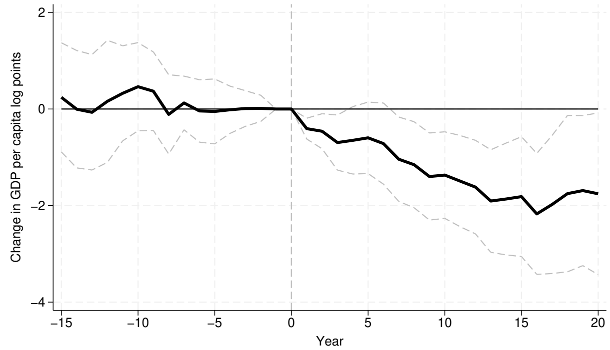
Figure B5: Heterogeneity in GDP per capita after tariff reductions: without controlling for 8 lags in growth rates



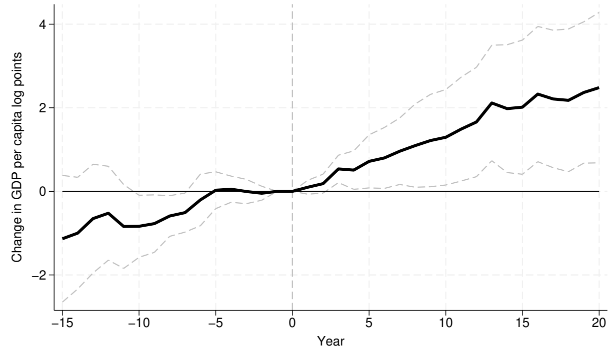
(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

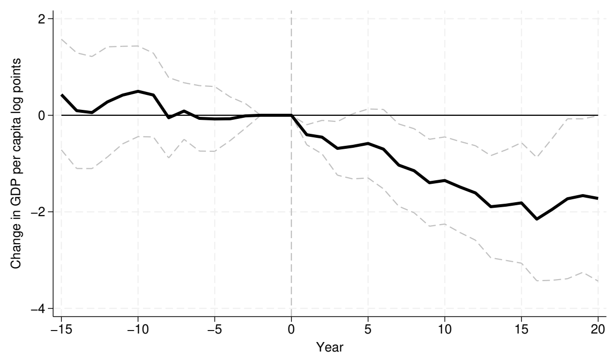
Figure B6: Heterogeneity in GDP per capita after tariff reductions: modelling selection with one or two lags of growth rates



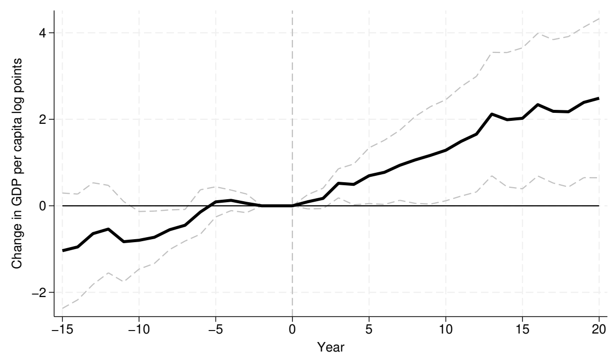
(a) Nonmanufacturers and one lag



(b) Manufacturers and one lag



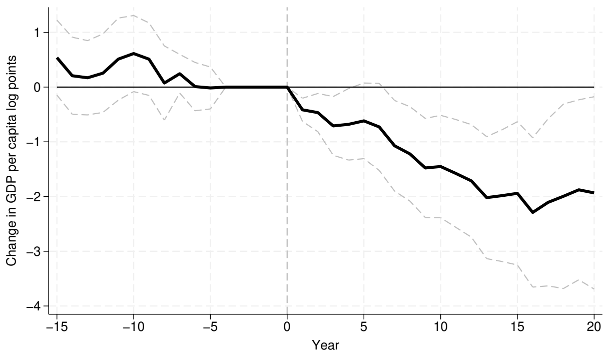
(c) Nonmanufacturers and two lags



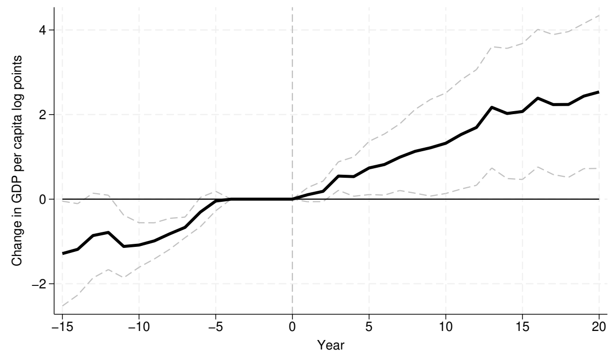
(d) Manufacturers and two lags

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

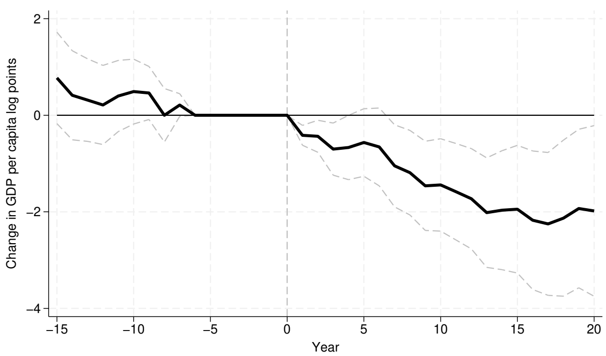
Figure B7: Heterogeneity in GDP per capita after tariff reductions: modelling selection with four or six lags of growth rates



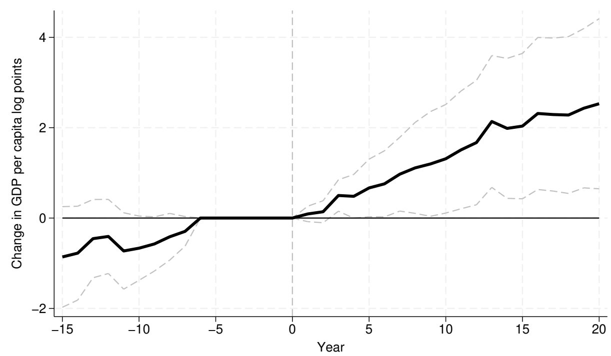
(a) Nonmanufacturers and four lags



(b) Manufacturers and four lags



(c) Nonmanufacturers and six lags



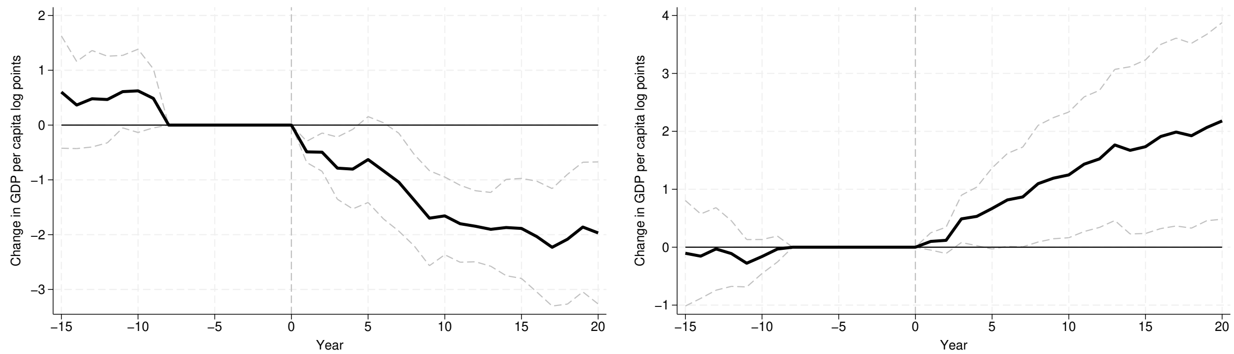
(d) Manufacturers and six lags

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

Alternative definitions of economic structure

I show here that the results are robust to different specifications of the initial economic structure. In the baseline specification, I define the initial economic structure as the average of the previous five years of the share of manufacturing exports, following the broad classification of goods in the SITC. Here, I replace this definition with six alternative ones. First, I use the average of the previous five years of the share of manufacturing exports, following Lall's (2000) classification. Second, I use the average of the previous five years of the revealed comparative advantage in manufacturing exports, using the broad category classification. Then, following the specifications proposed by Acemoglu et al. (2019) in a similar exercise, I define the initial economic structure as the first lag of the share of manufacturing exports, the value of manufacturing exports in 1962 (the first year for which trade data are available), the value of manufacturing exports in 1970, and, finally, the value in 1980.

Figure B8: Heterogeneity in GDP per capita after tariff reductions: using Lall's (2000) classification

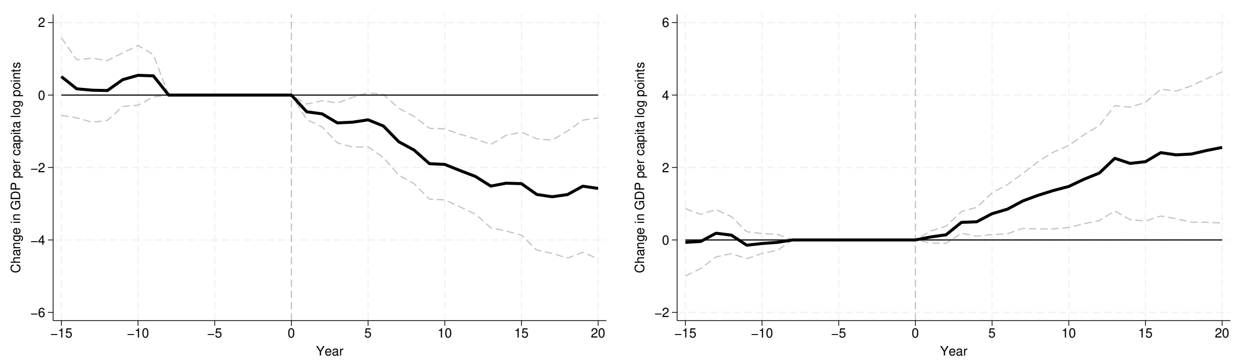


(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: Initial economic structure is defined as the average of the previous five years of the share of manufacturing exports, using Lall's (2000) classification. The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

Figure B8 reveals the result of using the initial economic structure defined using manufacturing exports with Lall's (2000) classification. The heterogeneity is still significant.

Figure B9: Heterogeneity in GDP per capita after tariff reductions: using revealed comparative advantage

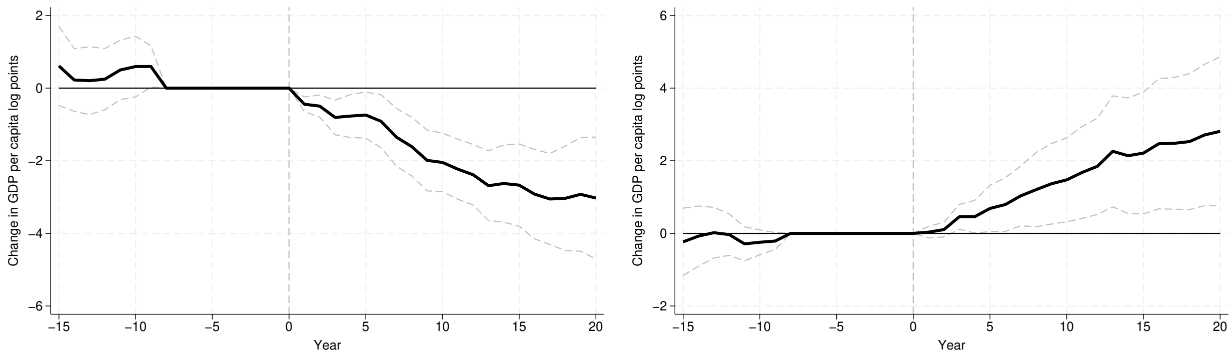


(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: Initial economic structure is defined as the average of the previous five years of revealed comparative advantage in manufacturing exports. The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

Figure B9 reveals the results when I use revealed comparative advantage instead of the share of manufacturing exports. The results are virtually the same as those in the baseline.

Figure B10: Heterogeneity in GDP per capita after tariff reductions: 3rd alternative definition of initial economic structure

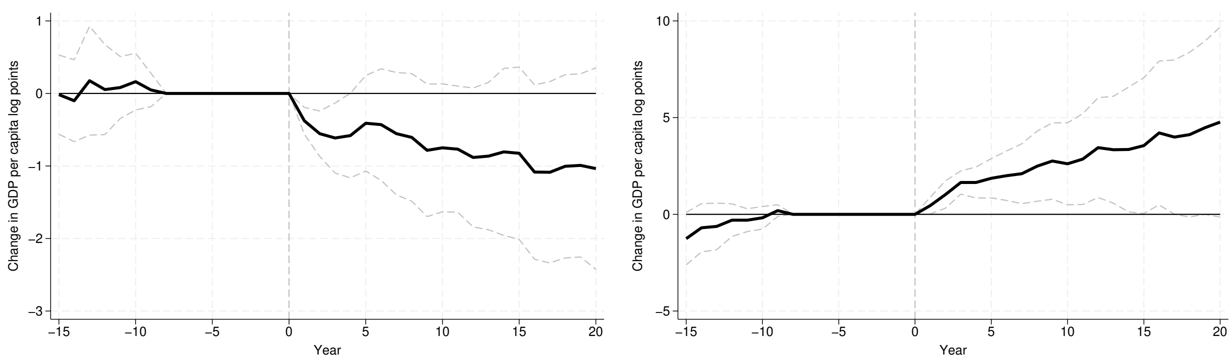


(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: Initial economic structure is defined as the first lag of the share of manufacturing exports. The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

Figure B10 reveals the results where the initial economic structure is defined by the first lag of the share of manufacturing exports. The heterogeneity in the results still holds.

Figure B11: Heterogeneity in GDP per capita after tariff reductions: 4th alternative definition of initial economic structure

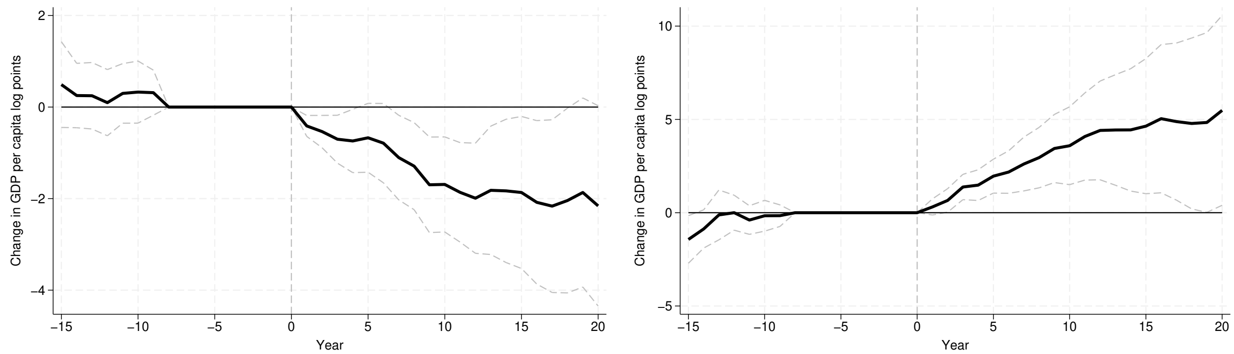


(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: Initial economic structure is defined as the the share of manufacturing exports in 1962. The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

Figure B11 reveals the results where the initial economic structure is the value of the share of manufacturing exports in 1962, the initial year of the trade data. The heterogeneity still holds, but the results are less precise, as the data for 1962 is scarcer.

Figure B12: Heterogeneity in GDP per capita after tariff reductions: 5th alternative definition of initial economic structure

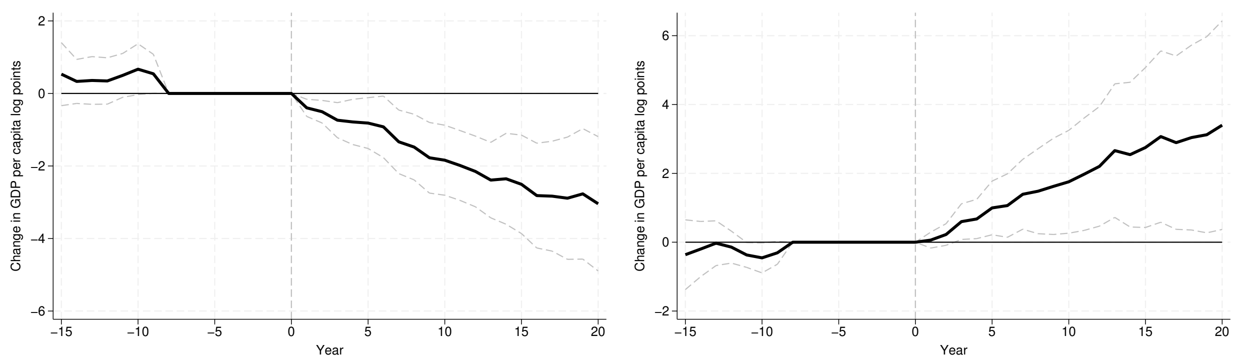


(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: Initial economic structure is defined as the the share of manufacturing exports in 1970. The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

Figure B12 reveals the results where the initial economic structure is the value of the share of manufacturing exports in 1970. The heterogeneity still holds.

Figure B13: Heterogeneity in GDP per capita after tariff reductions: 6th alternative definition of initial economic structure



(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: Initial economic structure is defined as the the share of manufacturing exports in 1980. The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

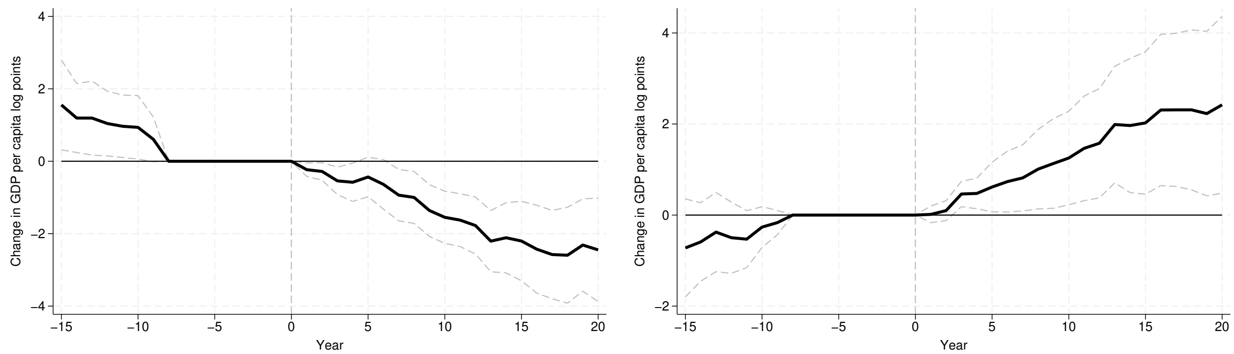
Figure B13 reveals the results where the initial economic structure is given by the value of the share of manufacturing exports in 1980. The heterogeneity in the results is still significant, and the magnitudes are even bigger.

Robustness to GDP data

I show here that the baseline results are robust to alternative GDP data.

Figure B14 reveals the results when I use GDP per capita from the World Development Indicators (WDI) in constant national prices. The correlations are negative and significant for nonmanufacturer countries and positive and significant for manufacturer countries.

Figure B14: Heterogeneity in GDP per capita after tariff reductions: data from WDI



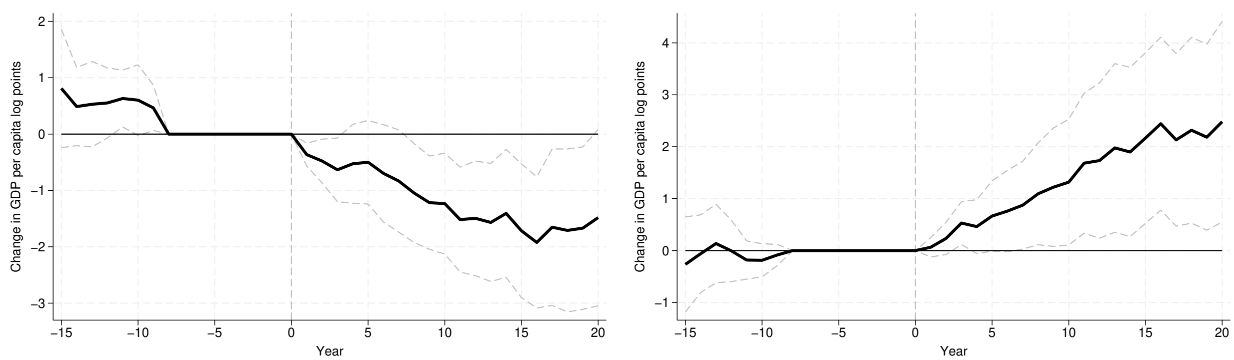
(a) For nonmanufacturer countries

(b) For manufacturer countries

Note: The GDP per capita data used for this figure are in constant national prices from the WDI. The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

Figure B15 reveals the results when I use data from the Maddison Project (Bolt & van Zanden, 2020). The estimates are more erratic but still point to a significant heterogeneity.

Figure B15: Heterogeneity in GDP per capita after tariff reductions: data from the Maddison Project



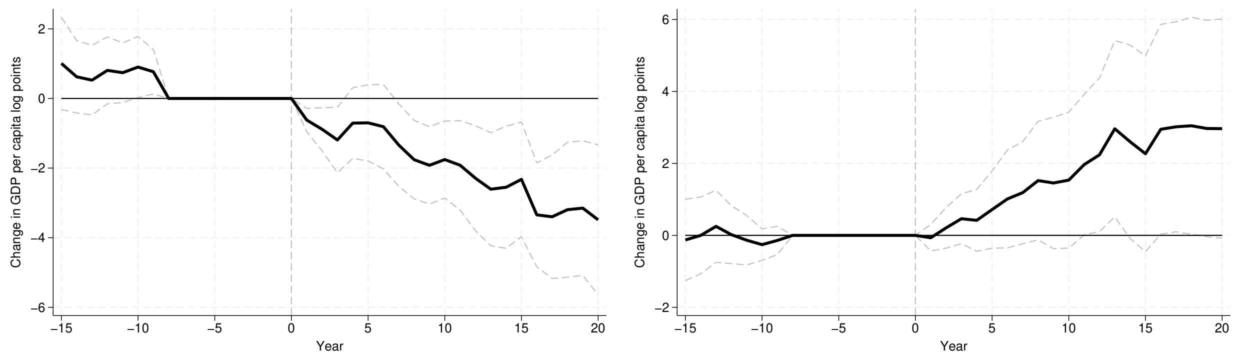
(a) For nonmanufacturer countries

(b) For manufacturer countries

Note: The GDP per capita data used for this figure are in constant national prices from the Maddison Project. The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

Finally, in Figure B16 I present the results based on GDP per capita data in purchasing power parity (PPP) constant terms from Penn World Table (PWT) 10.0. The results are negative and significant for nonmanufacturer countries and positive but mostly insignificant for manufacturer countries.

Figure B16: Heterogeneity in GDP per capita after tariff reductions: data in PPP from PWT



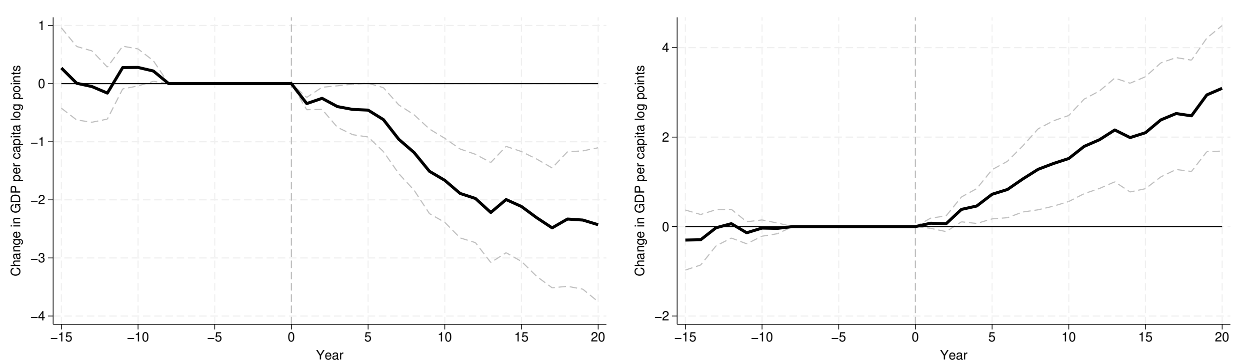
(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: The GDP per capita data used for this figure are in PPP constant terms from PWT 10.0 The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

Robustness to outlier observations

I next show that the results are robust to the use of outlier-robust regression methods and consideration of the influence of leverage points.

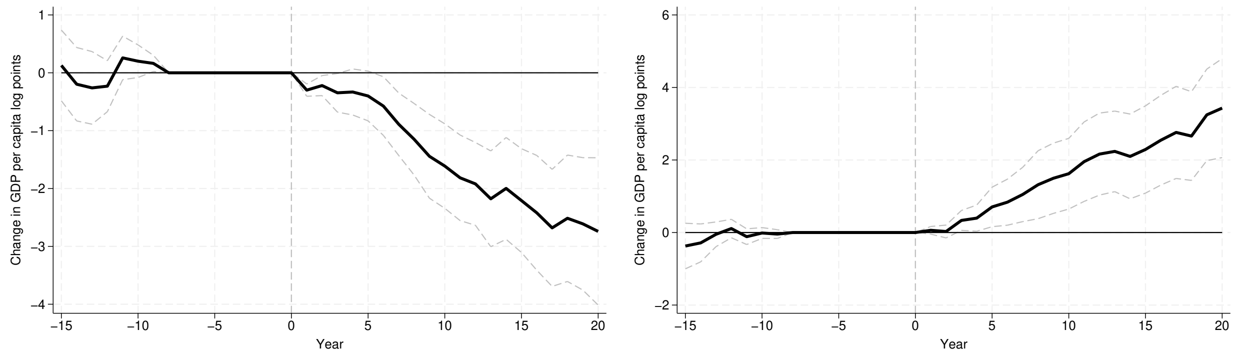
Figure B17: Heterogeneity in GDP per capita after tariff reductions: regressions with Huber weights



(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

Figure B18: Heterogeneity in GDP per capita after tariff reductions: Li's robust regressions

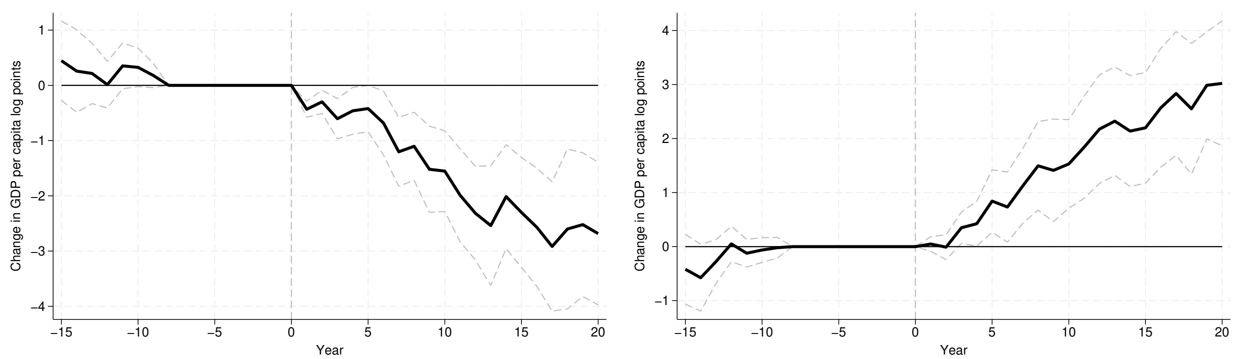


(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

Figure B17 reveals the results of using Huber (1964) weights and Figure B18 shows the results of using G. Li (1985)'s robust regression, deemed an improvement on Huber weights. The heterogeneity in the results is still significant and the magnitude is bigger.

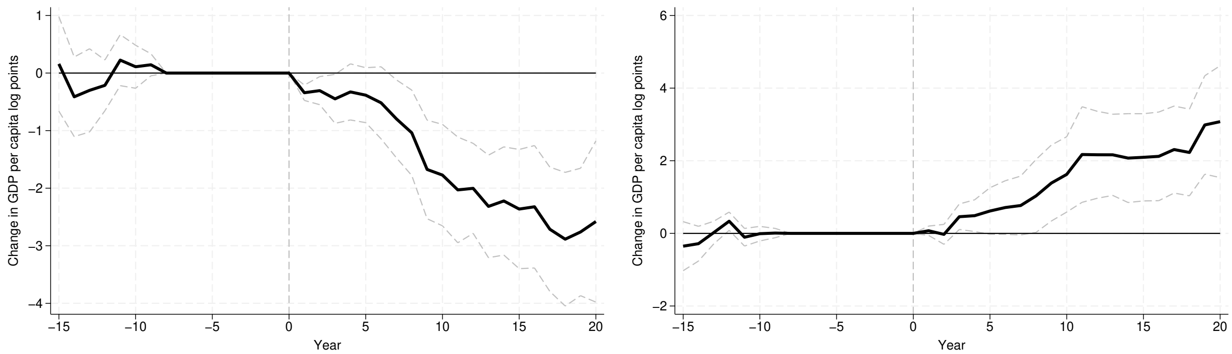
Figure B19: Heterogeneity in GDP per capita after tariff reductions: removing Cook's distance leverage points



(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

Figure B20: Heterogeneity in GDP per capita after tariff reductions: removing R-standardized leverage points

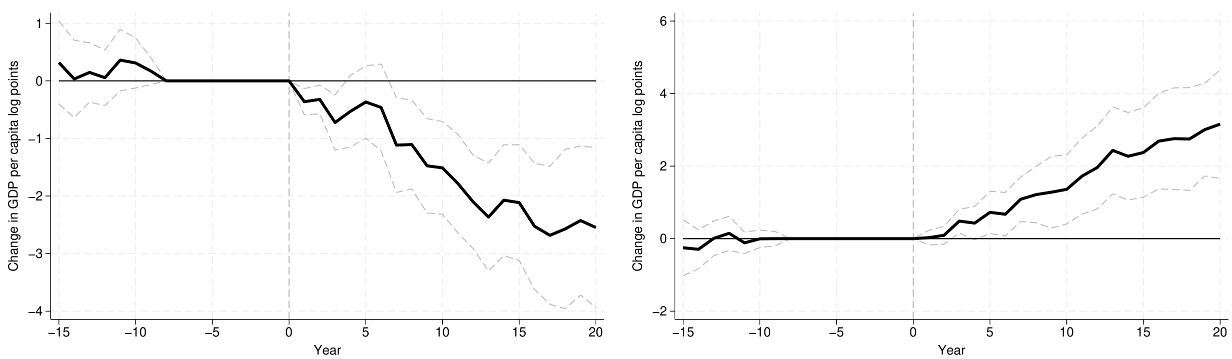


(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

I also consider the influence of leverage points by following the methods of deletion proposed by Belsley, Kuh, and Welsch (1980). Figures B19, B20, B21, B22 and B23 reveal that the results are robust to deletion of Cook's, R-standardized, Dfits, Hat and Covratio outliers, respectively.

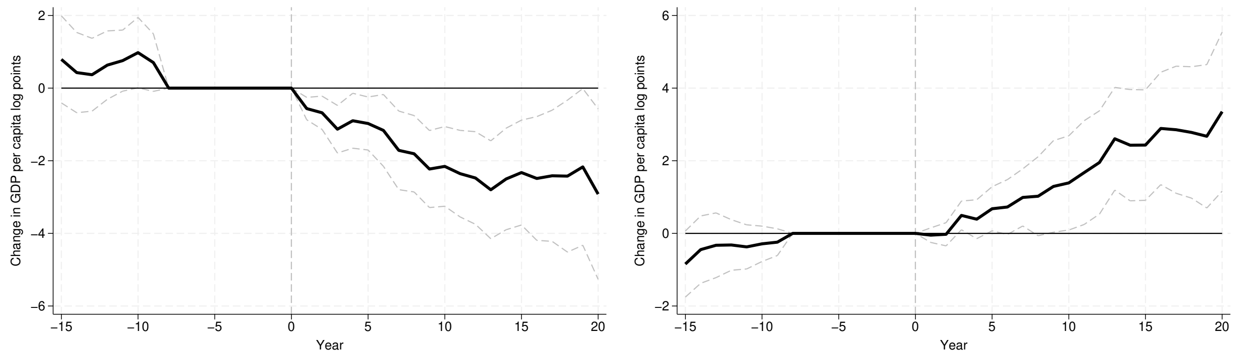
Figure B21: Heterogeneity in GDP per capita after tariff reductions: removing Dfits leverage points



(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

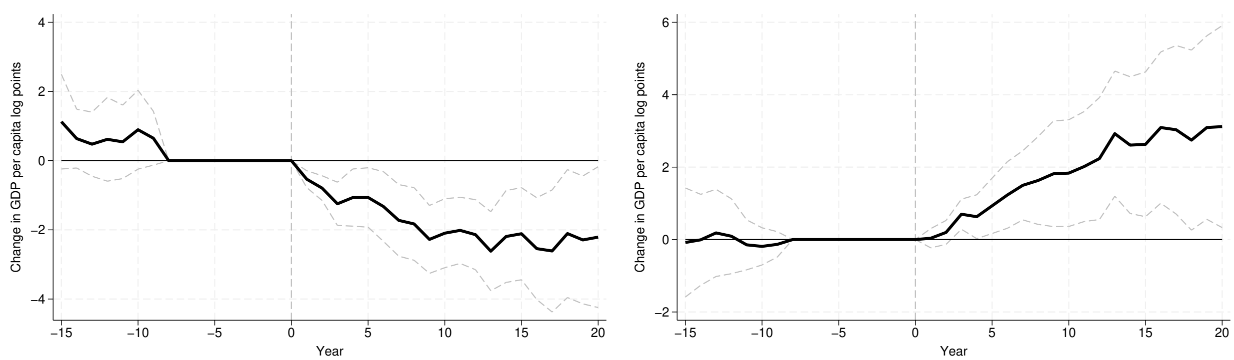
Figure B22: Heterogeneity in GDP per capita after tariff reductions: removing Hat leverage points



(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

Figure B23: Heterogeneity in GDP per capita after tariff reductions: removing Covratio leverage points



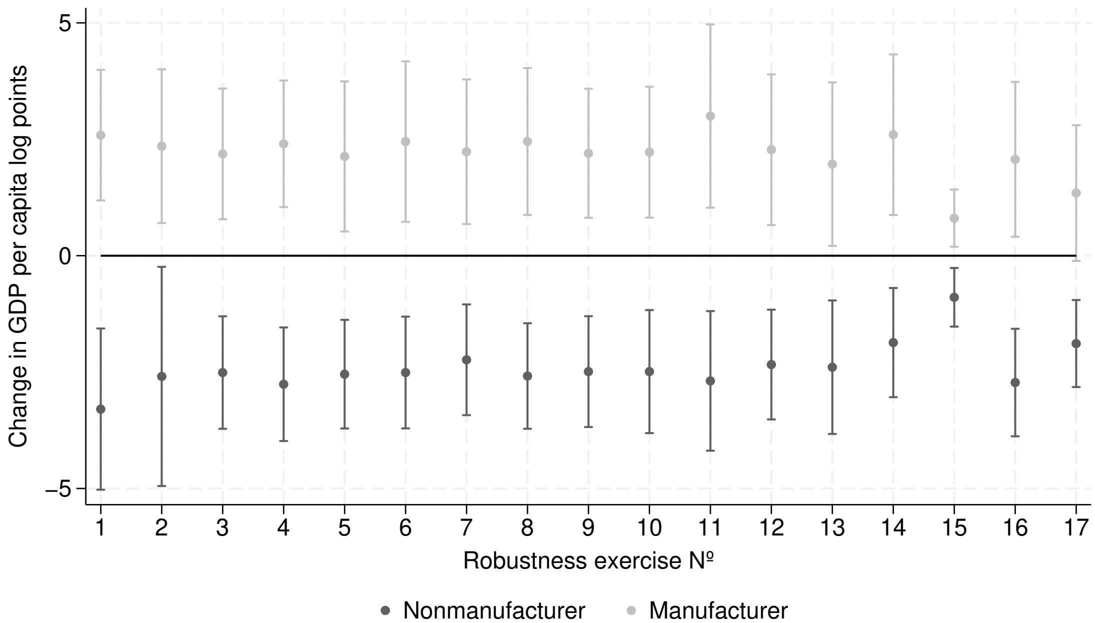
(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

Endogenous trade policy and other confounders

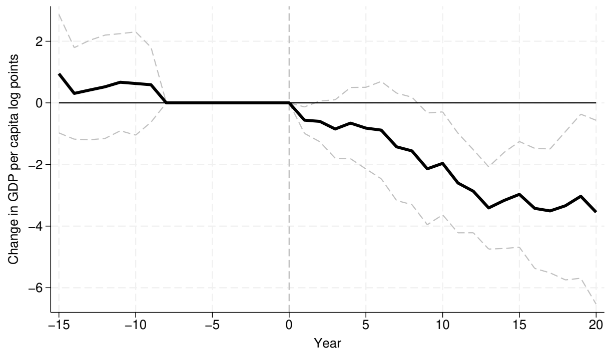
This subsection of the Appendix shows results associated to the two subsections of the title as found in the robustness section in the main text. I first show a graph summarizing all robustness carried out, Figure B24. After that, I reveal impulse responses for each individual robustness exercise in turn. At the end, I perform three additional checks. First, I check if results are robust to changes in contemporaneous covariates. Second, I check for all covariate changes at the same time. And third, I check for heterogeneities by economic structure in each one of the covariate changes considered.

Figure B24: Heterogeneity in GDP per capita between 13-17 years after tariff reductions: robustness

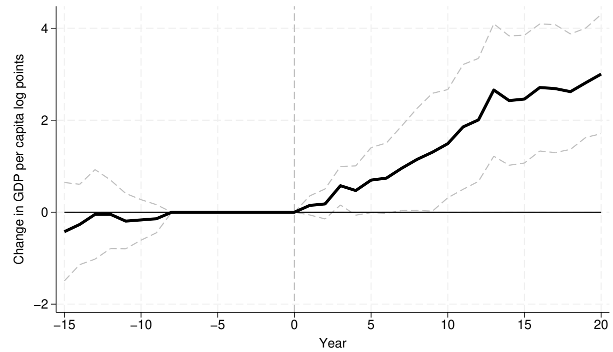


Note: The estimates presented are the predicted values for the 10th and 90th percentiles of the distribution of initial manufacturing exports. The coefficients display the average of the estimates for each year between 13 and 17 years after tariff reductions. The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level. Exercise 1 is the outcome of estimating equation 3 with the change in the growth forecast as a covariate. Exercise 2 is the outcome of estimating equation 3 with four lags of the change in the Gini coefficient. Exercise 3 is the outcome of estimating equation 3 with four lags of the change in import penetration. Exercise 4 is the outcome of estimating equation 3 with four lags of the change in nontariff barriers. Exercise 5 is the outcome of estimating equation 3 with four lags of the change in capital account openness. Exercise 6 is the outcome of estimating equation 3 with four lags of the change in Polity. Exercise 7 is the outcome of estimating equation 3 with four lags of the change in human capital. Exercise 8 is the outcome of estimating equation 3 with four lags of the change in the population size. Exercise 9 is the outcome of estimating equation 3 with four lags of the change in trade openness. Exercise 10 is the outcome of estimating equation 3 with four lags of the change in investment. Exercise 11 is the outcome of estimating equation 3 with four lags of the change in the real exchange rate. Exercise 12 is the outcome of estimating equation 3 with four lags of the change in the terms of trade. Exercise 13 is the outcome of estimating equation 3 with heterogeneity from income. Exercise 14 is the outcome of estimating equation 3 with heterogeneity from human capital. Exercise 15 is the outcome of estimating equation 3 with country fixed effects. Exercise 16 is the outcome of estimating equation 3 with different trends for country groups by income. Exercise 17 is the outcome of estimating equation 3 with different trends for country regions.

Figure B25: Heterogeneity in GDP per capita after tariff reductions: controlling for the change in the growth forecast



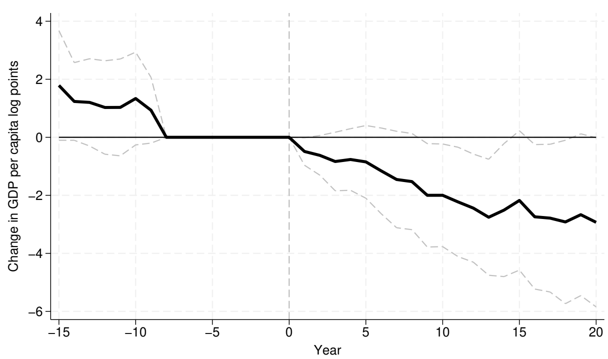
(a) For nonmanufacturer countries



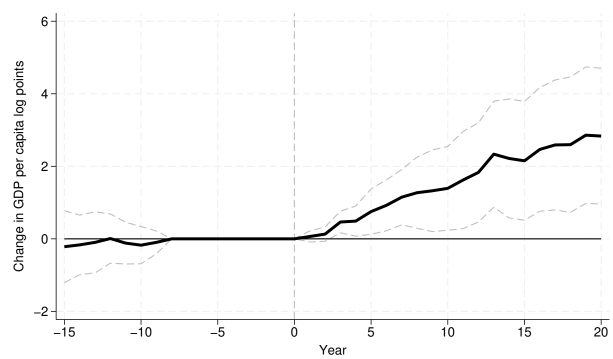
(b) For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

Figure B26: Heterogeneity in GDP per capita after tariff reductions: controlling for four lags of the change in the Gini coefficient



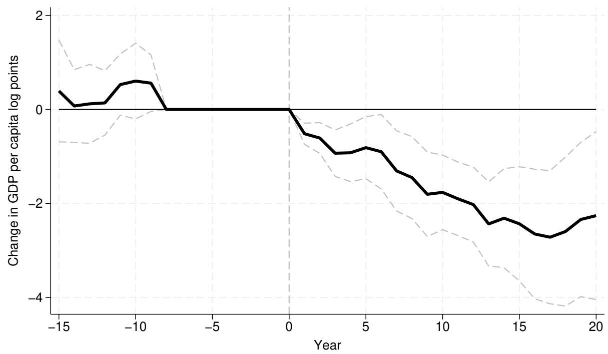
(a) For nonmanufacturer countries



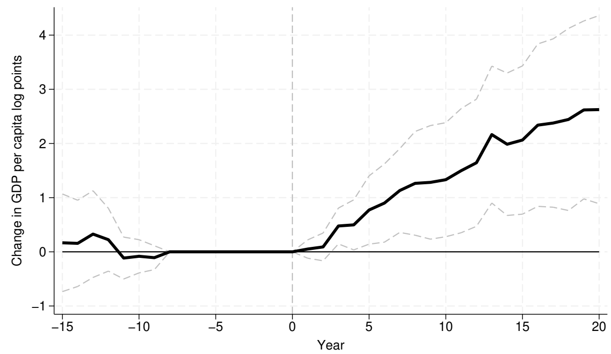
(b) For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

Figure B27: Heterogeneity in GDP per capita after tariff reductions: controlling for four lags of the change in import penetration



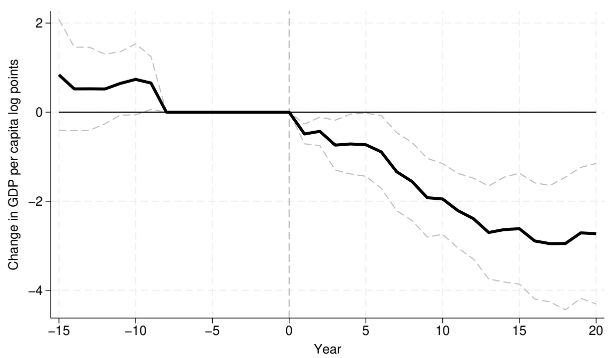
(a) For nonmanufacturer countries



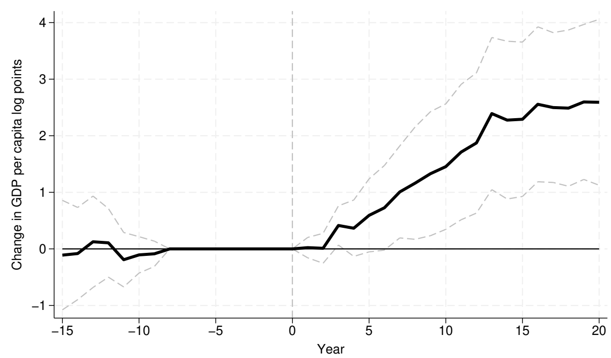
(b) For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

Figure B28: Heterogeneity in GDP per capita after tariff reductions: controlling for four lags of the change in nontariff barriers



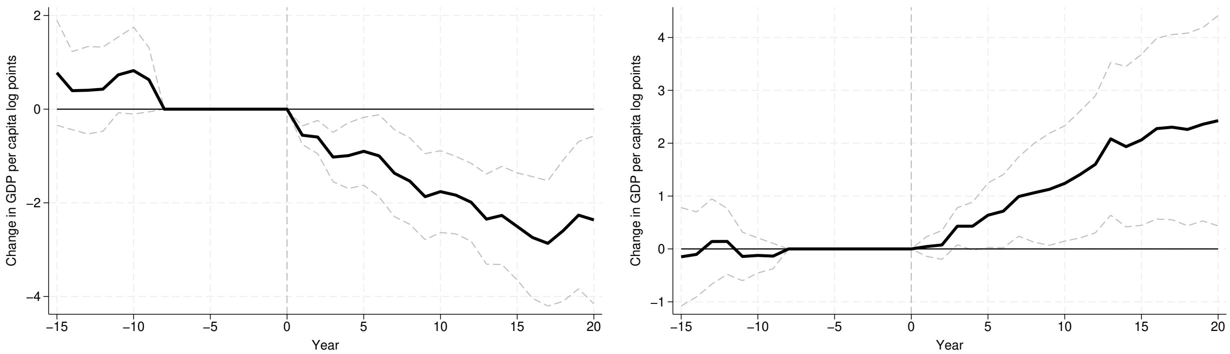
(a) For nonmanufacturer countries



(b) For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

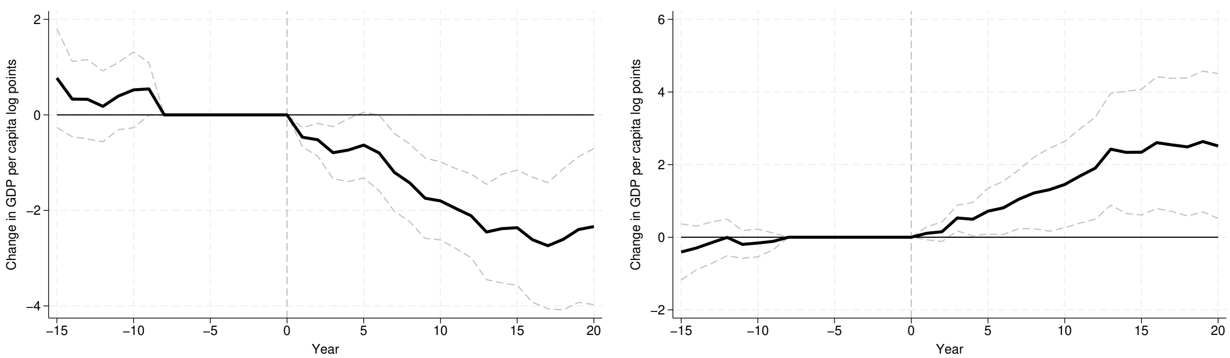
Figure B29: Heterogeneity in GDP per capita after tariff reductions: controlling for four lags of the change in capital account openness



(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

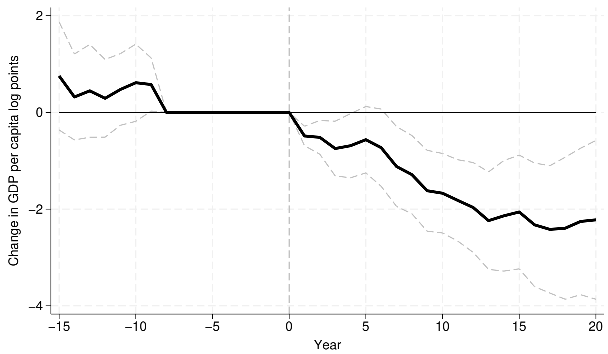
Figure B30: Heterogeneity in GDP per capita after tariff reductions: controlling for four lags of the change in Polity



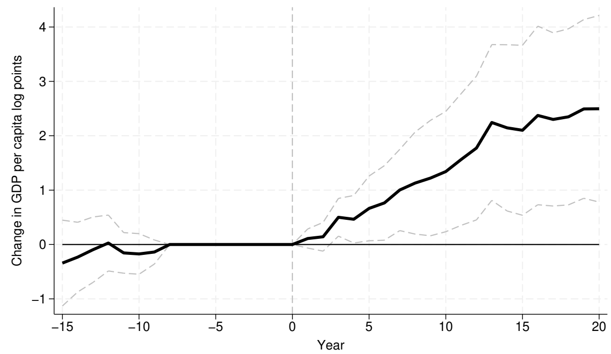
(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

Figure B31: Heterogeneity in GDP per capita after tariff reductions: controlling for four lags of the change in human capital



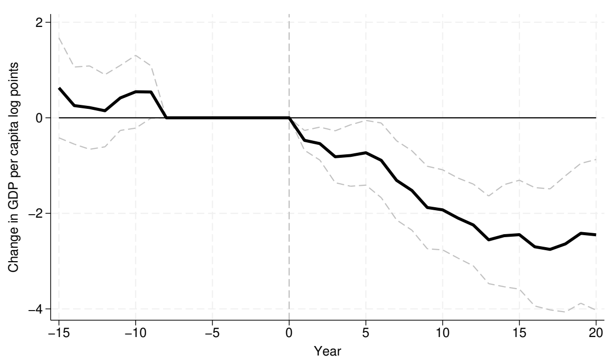
(a) For nonmanufacturer countries



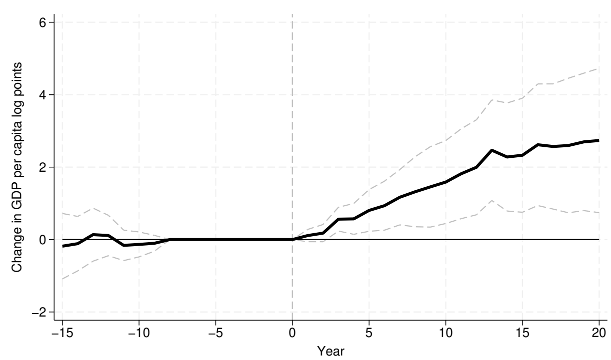
(b) For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

Figure B32: Heterogeneity in GDP per capita after tariff reductions: controlling for four lags of the change in population size



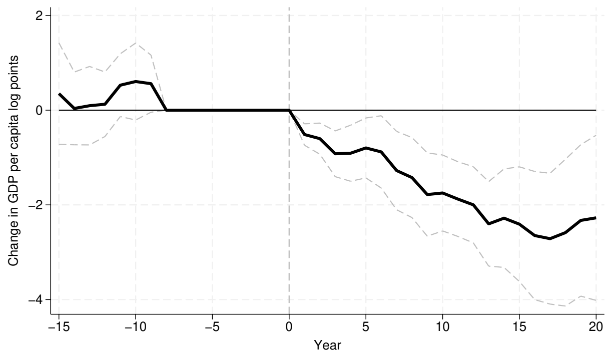
(a) For nonmanufacturer countries



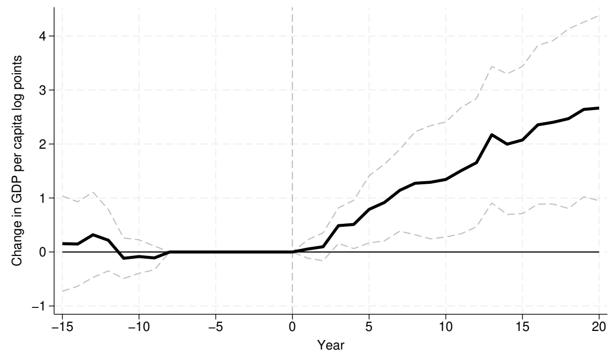
(b) For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

Figure B33: Heterogeneity in GDP per capita after tariff reductions: controlling for four lags of the change in trade as share of GDP



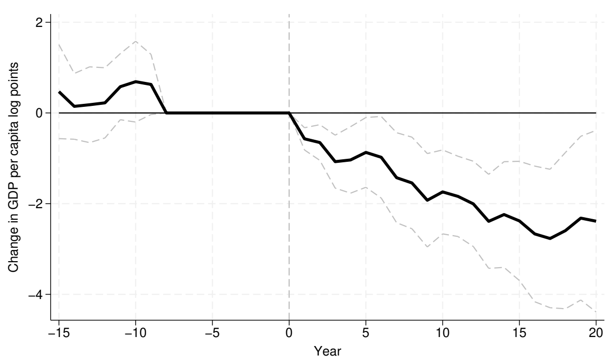
(a) For nonmanufacturer countries



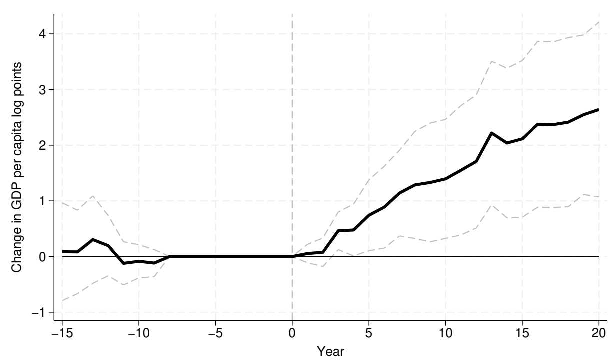
(b) For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

Figure B34: Heterogeneity in GDP per capita after tariff reductions: controlling for four lags of the change in investment



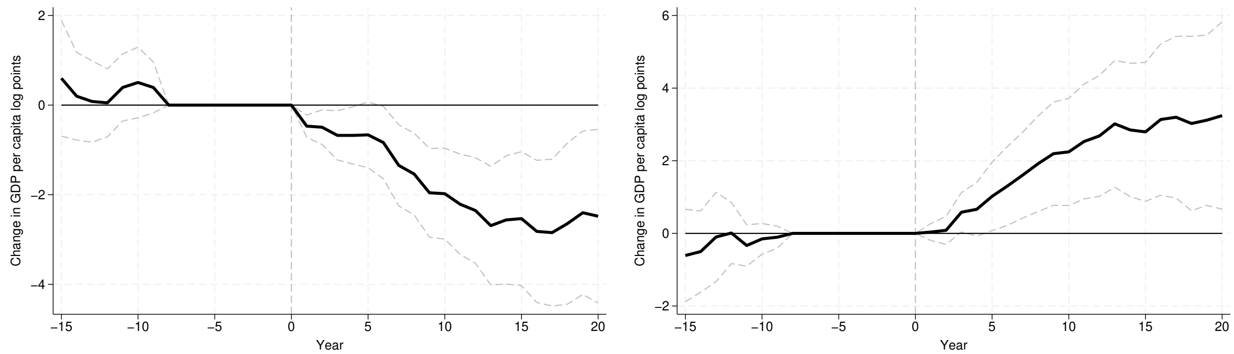
(a) For nonmanufacturer countries



(b) For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

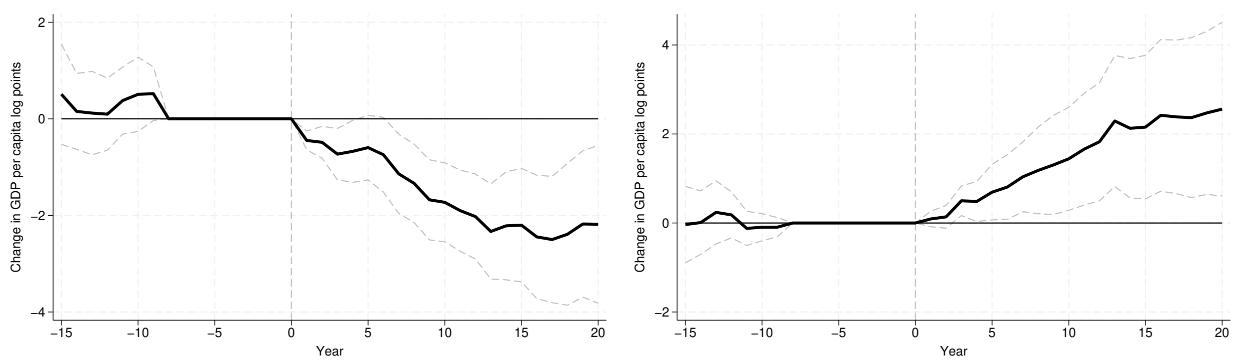
Figure B35: Heterogeneity in GDP per capita after tariff reductions: controlling for four lags of the change in real exchange rates



(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

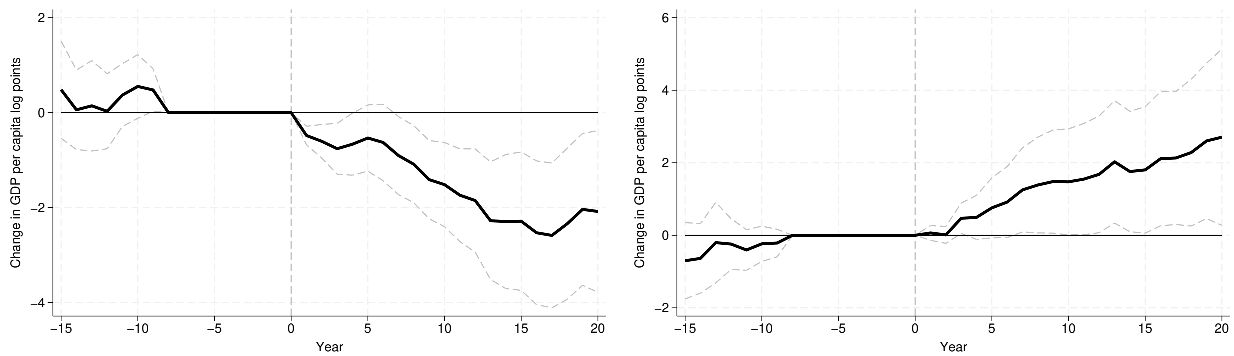
Figure B36: Heterogeneity in GDP per capita after tariff reductions: controlling for four lags of the change in terms of trade



(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

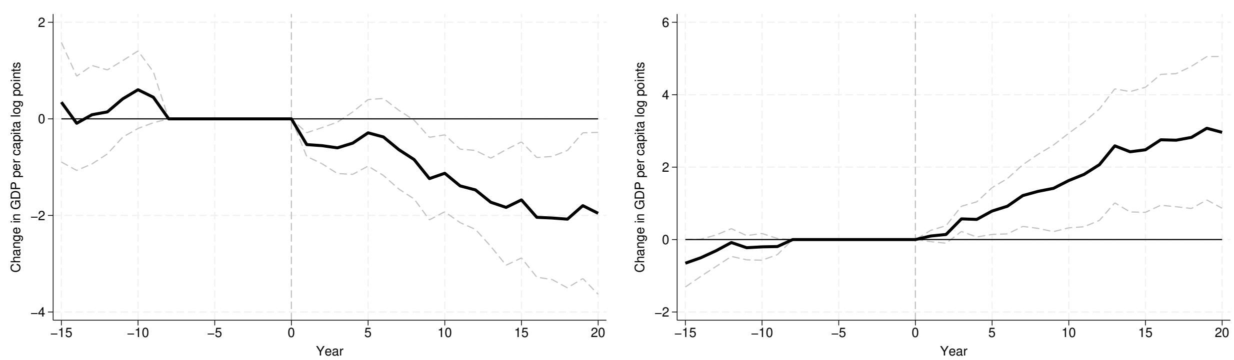
Figure B37: Heterogeneity in GDP per capita after tariff reductions: controlling for a heterogeneous relationship in relation to income



(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

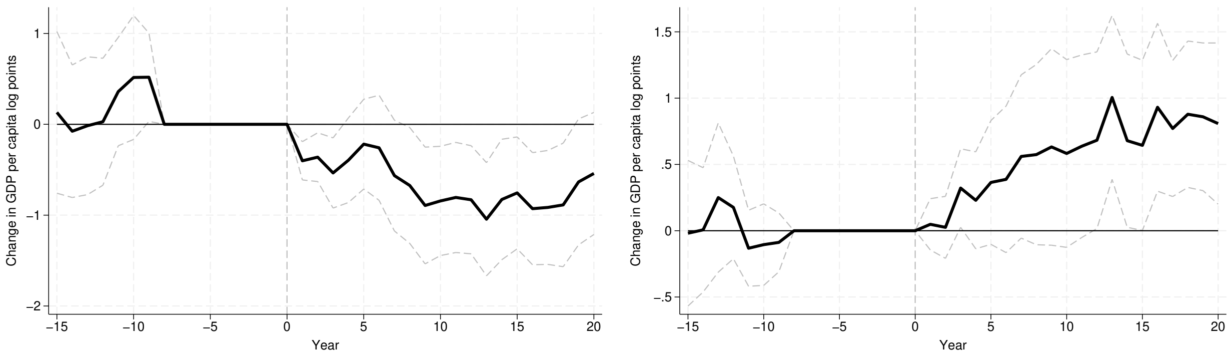
Figure B38: Heterogeneity in GDP per capita after tariff reductions: controlling for a heterogeneous relationship in relation to human capital



(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

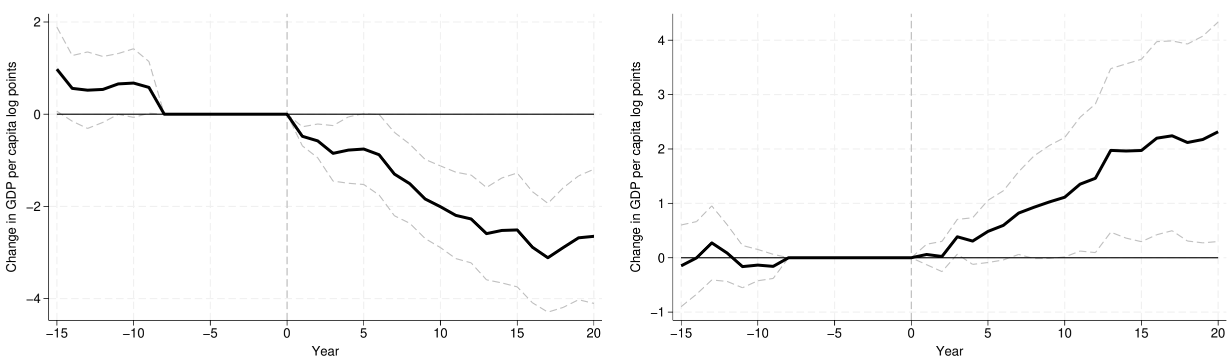
Figure B39: Heterogeneity in GDP per capita after tariff reductions: including country fixed effects



(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

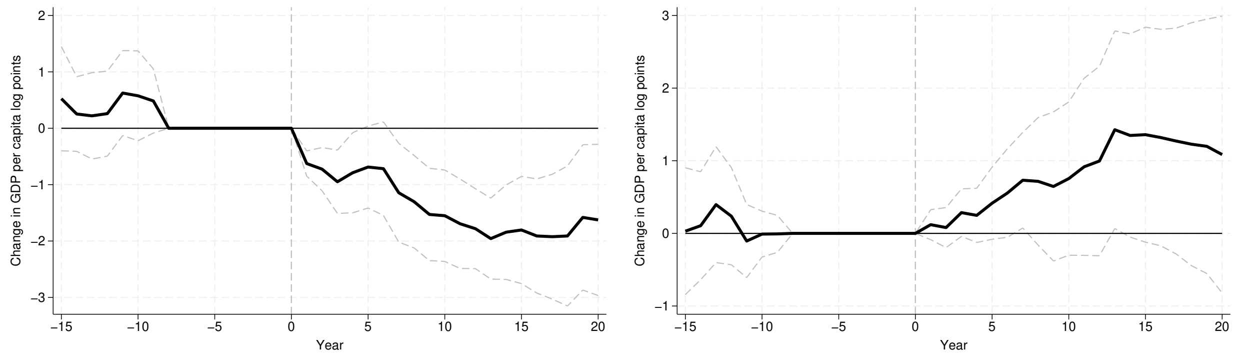
Figure B40: Heterogeneity in GDP per capita after tariff reductions: controlling for trends in different country income groups



(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

Figure B41: Heterogeneity in GDP per capita after tariff reductions: controlling for trends in different regions of countries



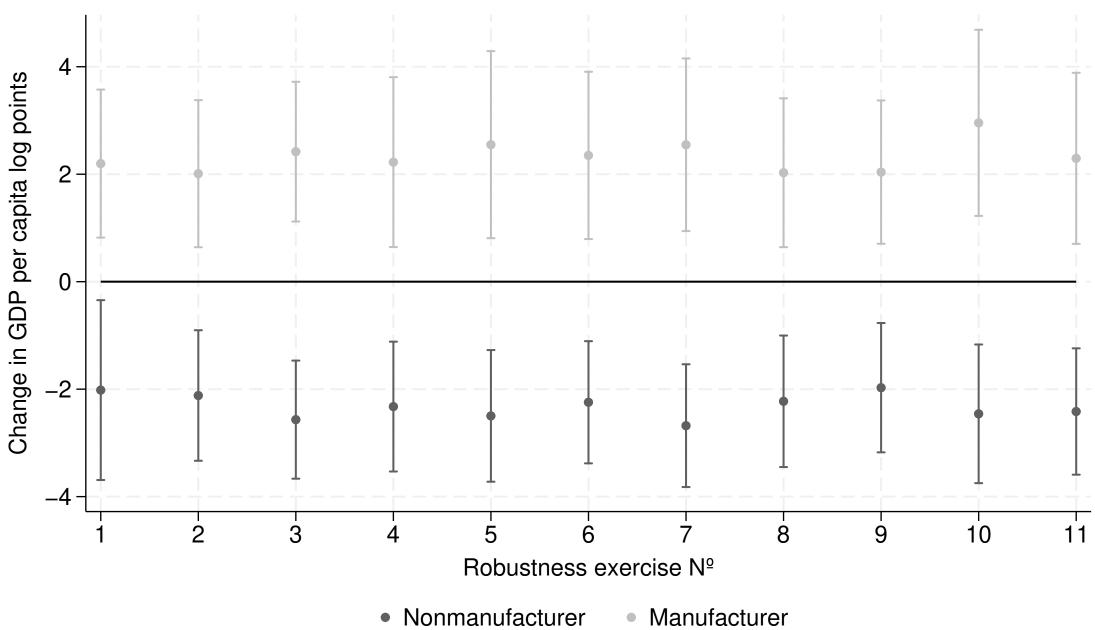
(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

Robustness to contemporaneous changes in covariates

In the main text, I use a specification with four lags of the changes in covariates to account for potential confounding variables. Here, I simply summarize the results obtained if, instead, I include the contemporaneous change in each covariate. Figure B42 shows the results, confirming the heterogeneity.

Figure B42: Heterogeneity in GDP per capita after tariff reductions: robustness to contemporaneous changes in relevant covariates

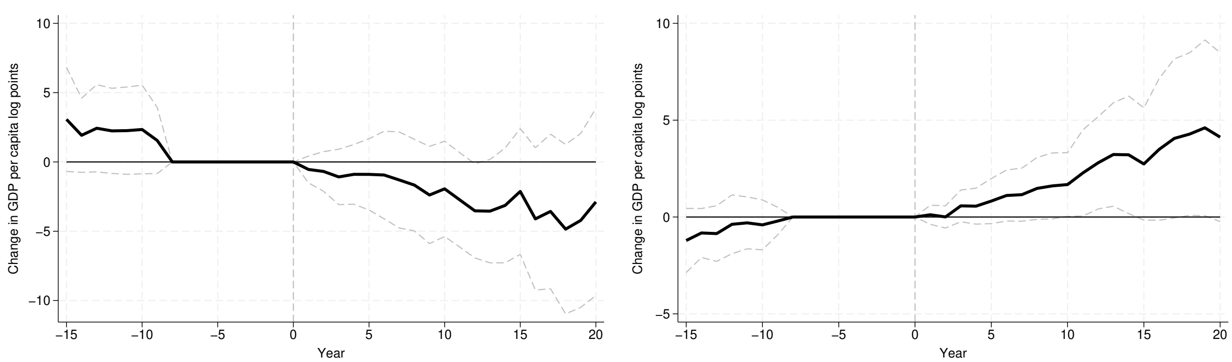


Note: The estimates presented are the predicted values for the 10th and 90th percentiles of the distribution of initial manufacturing exports. The coefficients show the average of the estimates 10-14 years after the change in tariffs. The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level. Exercise 1 is the outcome of estimating equation 3 with the change in the Gini coefficient. Exercise 2 is the outcome of estimating equation 3 with the change in import penetration. Exercise 3 is the outcome of estimating equation 3 with the change in nontariff barriers. Exercise 4 is the outcome of estimating equation 3 with the change in capital account openness. Exercise 5 is the outcome of estimating equation 3 with the change in Polity. Exercise 6 is the outcome of estimating equation 3 with the change in human capital. Exercise 7 is the outcome of estimating equation 3 with the change in population size. Exercise 8 is the outcome of estimating equation 3 with the change in trade openness. Exercise 9 is the outcome of estimating equation 3 with the change in investment. Exercise 10 is the outcome of estimating equation 3 with the change in the real exchange rate. Exercise 11 is the outcome of estimating equation 3 with the change in the terms of trade.

Robustness with all controls included at the same time

In the main text, I control for several covariates that might affect the validity of the estimates, by including each of them in turn. The validity of the results, therefore, may still be subject to the criticism that it is driven by correlations between covariates, not captured in the regressions when controlling for each of them in turn. I now present the results of including all covariates at the same time. This exercise is extremely demanding in terms of statistical power, as the sample is importantly reduced, given that for each covariate I include four lags of first differences and information is not equally available for all countries. Results are presented in Figure B43. The direction of the heterogeneity is still in line with the main findings, and although significance is importantly reduced, I still observe a significant relation around 12-13 years after tariff reductions.

Figure B43: Heterogeneity in GDP per capita after tariff reductions: all control variables included at the same time



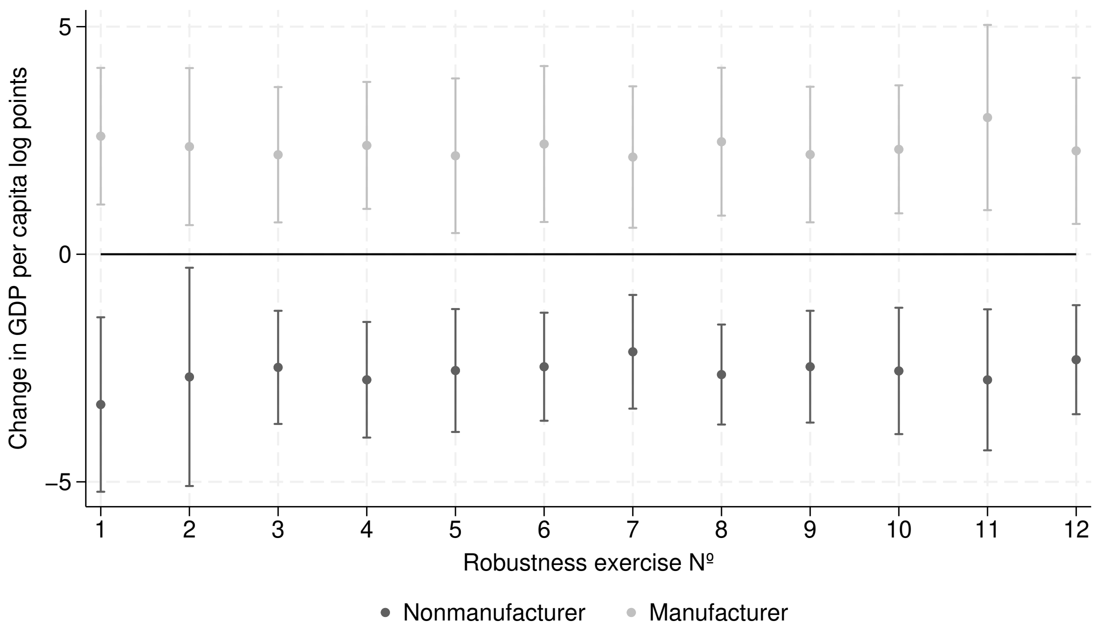
(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

Robustness to heterogeneities by economic structure from covariates

An additional concern is that nonmanufacturers and manufacturers are differentially exposed to and affected by the potential confounders, discussed thoroughly in the first two subsections of Section 5. It could be the case, for example, that both nonmanufacturers are exposed to nontariff barriers differently than manufacturers and that the association between nontariff barriers and growth varies with economic structure. These concerns may generate potential biases in the heterogeneity estimates. To address these concerns, I estimate a slightly modified version of equation 3 where I interact economic structure with each of the variables discussed in robustness subsections endongenous trade policy and other confounders. Results of these exercises are summarized in Figure B44, where the average association between tariff reductions and GDP between 13 and 17 years after tariff reductions is depicted. The heterogeneity holds.

Figure B44: Heterogeneity in GDP per capita between 13-17 years after tariff reductions: robustness to interactions between covariates and economic structure



Note: The estimates presented are the predicted values for the 10th and 90th percentiles of the distribution of initial manufacturing exports. The coefficients display the average of the estimates for each year between 13 and 17 years after tariff reductions. The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level. Exercise numbers refer to the same ones presented in Figure B24.

Instrumental variable

The instrumental variables approach in the paper follows closely the application by Furceri et al. (2022). More specifically, I use their proposed instrument for tariff changes to specifically test for the existence of the heterogeneity by economic structure. The instrument consists on a weighted average of tariff changes in the 5 major trading partners by country by year. The weights are provided by total trade between the country and each trading partner, calculated over total trade of the country.

The first stage, to arguably get exogenous variation of tariff changes, is given by the following equation:

$$\Delta TA_{c,t} = \lambda Inst_{c,t} + \phi_h m_{c,t} + \sum_{j=1}^{8} \sigma_h^j g_{c,t-j} + \alpha_t + \epsilon_{c,t} \tag{7}$$

where λ captures the first stage coefficient of interest. The specifcation includes year fixed effects, the eight lags in growth rates as in the baseline and the economic structure. We use the coefficients of this regression to predict tariff changes as a function only of these controls, and particularly as a function of the instrument, $Inst$.

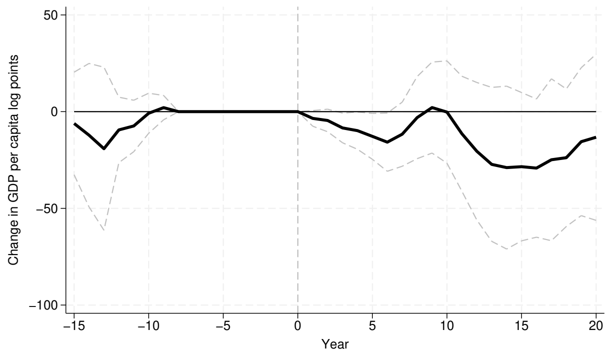
The set of second stage regressions is given by the following equations, estimated for each horizon h:

$$y_{c,t+h} - y_{c,t-1} = \beta_h \widehat{\Delta TA_{c,t}} + \theta_h \widehat{\Delta TA_{c,t}} m_{c,t} + \phi_h m_{c,t} + \sum_{j=1}^{8} \sigma_h^j g_{c,t-j} + \alpha_t + \epsilon_{c,t} \tag{8}$$

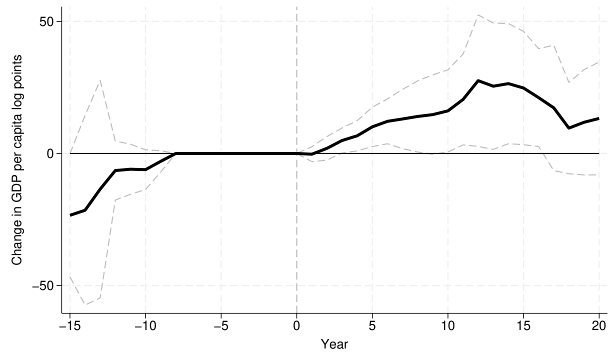
where we use the predicted tariff changes from the first stage both alone and within the interaction term with economic structure.

The previous system of equations is estimated using clustered bootstrapping, so that the second stage takes into account the sample uncertainty from the first and, as mentioned, to adequately perform inference, as signaled by Young (2022).

Figure B45: Heterogeneity in GDP per capita after tariff reductions: instrumental variables



(a) For nonmanufacturer countries



(b) For manufacturer countries

Note: The standard errors used for the figure are estimated using clustered bootstrapping by country, after 400 bootstraps. Confidence intervals are calculated to the 90% significance level.

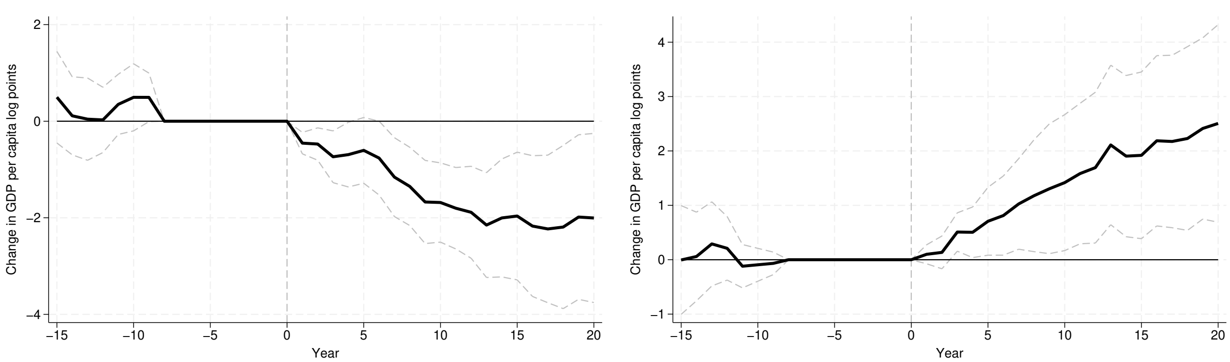
Additional robustness

The empirical analysis so far may still be subject to criticism with respect to three issues. First, it could be the case that the correlations between past and future growth depend on whether a country is a manufacturer and that global shocks (captured by year fixed effects) might be also different depending on manufacturing status. Second, when regressing the cumulative change in GDP at time $t + h$ on the tariff change observed at time t, I ignore tariff changes occurring between $t + 1$ and $t + h$, which may lead to biases, as highlighted by Teulings and Zubanov (2014). And finally, I propose an exercise to address endogeneity concerns of economic structure.

Heterogeneity in growth persistence and global shocks

The relationship between past and future growth could depend on whether a country is a manufacturer. If so, then by estimating a single set of lagged growth controls for all countries, any heterogeneity in these correlations is effectively relegated to the error term. By the same token, it could be the case that the experience of global shocks, as captured by year fixed effects, might differ based on whether the country is a manufacturer. If this is the case, controlling for interactions between the initial economic structure and year fixed effects might capture potential biases from it. The results are presented in Figures B46 and B47 and confirm the baseline findings.

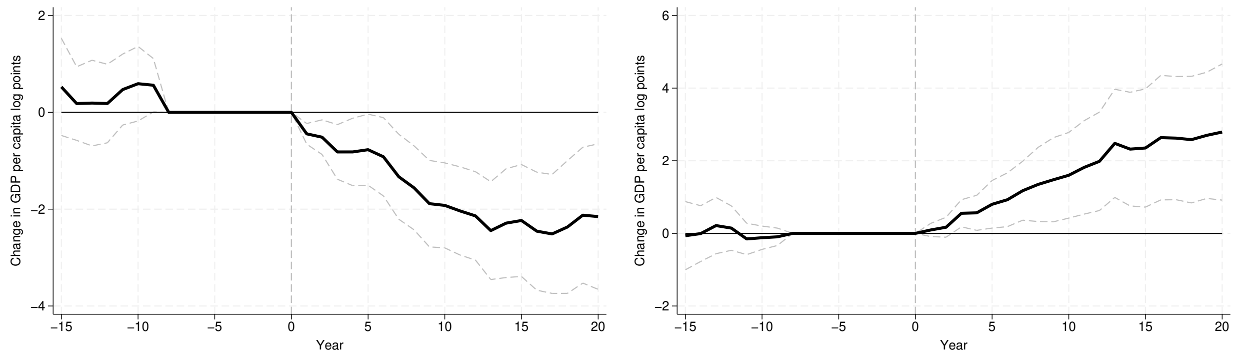
Figure B46: Heterogeneity in GDP per capita after tariff reductions: controlling for interactions between past growth and the initial economic structure



(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

Figure B47: Heterogeneity in GDP per capita after tariff reductions: controlling for interactions between year fixed effects and the initial economic structure



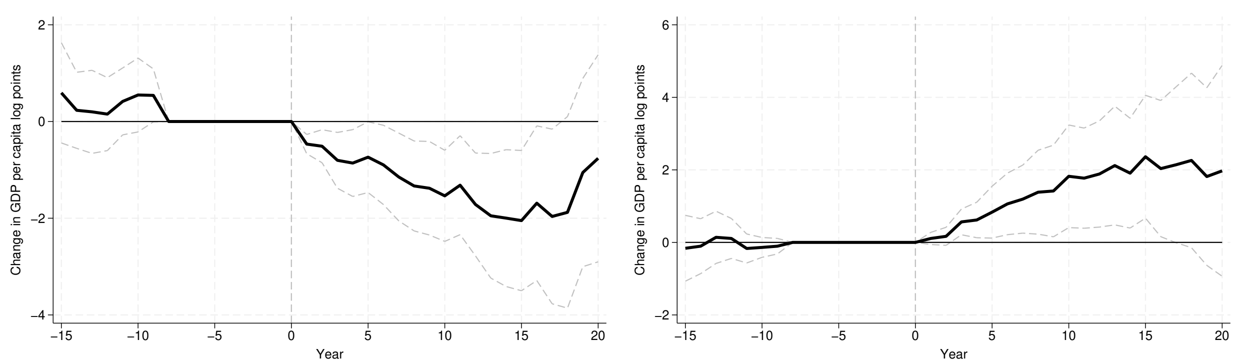
(a) For nonmanufacturer countries **(b)** For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

Tariff changes after tariff reductions

What if my estimate for period $t+9$ is not really the outcome of the tariff change at t but the change five years later? To check for this, I include in the baseline framework, equation 3, all tariff changes occurring before $t+h$, not only that in time t, following the proposed solution by Teulings and Zubanov (2014). The results of this exercise are presented in Figure B48. Although the estimates are less precise, as statistical power is lost, the heterogeneous relation holds.

Figure B48: Heterogeneity in GDP per capita after tariff reductions: controlling for other tariff changes



(a) For nonmanufacturer countries **(b)** For manufacturer countries

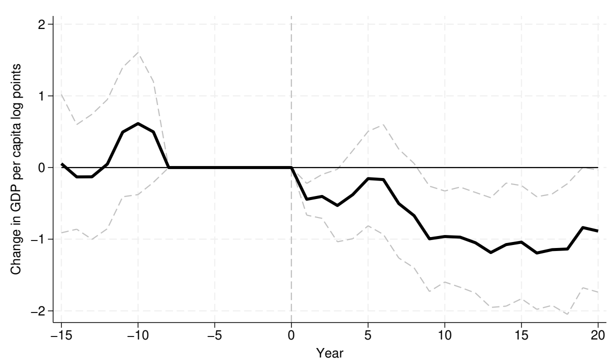
Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

Endogeneity of economic structure

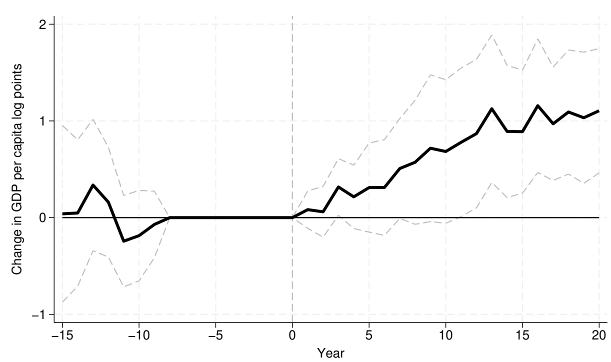
So far the discussion on potential biases in the heterogeneity has focused on the endogeneity of tariffs. But the identification of the interaction term might be biased due to the endogeneity of economic structure. To address this potential source of endogeneity, I assume that tariff changes are exogenous, based on the results obtained in the robustness exercises in previous subsections. And although Nizalova and Murtazashvili (2016) shows that if the source of heterogeneity, here economic structure, and the omitted source of endogeneity are jointly independent from the change of tariffs simple OLS identifies the interaction coefficient, I nonetheless provide an exercise to further relax this assumption.

I pursue an IV identification, following closely the application by Nunn and Qian (2014) in their causal analysis of US aid's impact on conflict. I exploit cross-sectional variation in economic structure, measured as the average economic structure by country in all sample years. I then calculate the interaction of this average of economic structure by country with the change in tariffs and use it as the instrument for the interaction of interest (i.e., the interaction between the time-varying economic structure and the time-varying change in tariffs). To control for the potential direct effect of the average economic structure, which if ignored might bias the estimates, I also include country fixed effects in the specification to purge all time invariant factors by country, as executed by Nunn and Qian (2014). Results of this exercise are presented in Figure B49, confirming the heterogeneity. Following Andrews, Stock, and Sun (2019), since this is a case of one endogenous regressor just-identified, I also report in Table B2 the Anderson-Rubin p-values for the interaction, robust to weak identification, which reassuringly confirm a significant heterogeneity, especially 8-20 years after tariff reductions.

Figure B49: Heterogeneity in GDP per capita after tariff reductions: IV estimates for endogenous economic structure



(a) For nonmanufacturer countries



(b) For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level. The interaction between tariff changes and economic structure is instrumented with an interaction of tariff changes and the average economic structure by country in the whole sample. To avoid potential additional biases related to a direct effect from this average economic structure, the specification also includes country fixed effects.

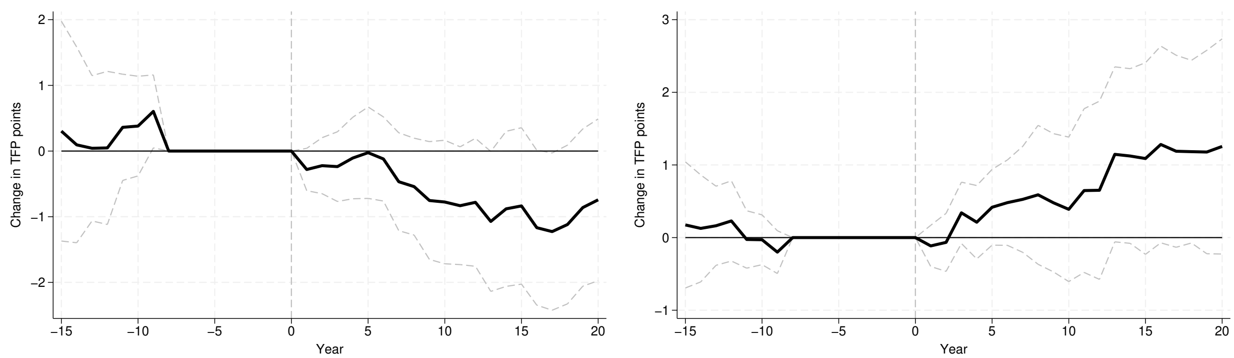
Table B2: Anderson-Rubin p-values for the IV coefficient for the interaction

Horizon of analysis	Sign	Anderson-Rubin P-value
-15	+	.988
-14	-	.835
-13	-	.593
-12	-	.891
-11	+	.335
-10	+	.351
-9	+	.354
-8	0	NA
-7	0	NA
-6	0	NA
-5	0	NA
-4	0	NA
-3	0	NA
-2	0	NA
-1	0	NA
0	0	NA
1	-	.050
2	-	.108
3	-	.033
4	-	.221
5	-	.391
6	-	.445
7	-	.110
8	-	.054
9	-	.019
10	-	.017
11	-	.013
12	-	.006
13	-	.001
14	-	.004
15	-	.005
16	-	.002
17	-	.006
18	-	.014
19	-	.028
20	-	.014

C Mechanisms

Finally, I show results of the relationship between tariff reductions and TFP, as an alternative to labor productivity, and tariff reductions and the share of imports in GDP. Direction of the correlations for TFP go in line with the results documented with labor productivity, although the results are not significant at the 90 percent level of confidence. Results for the share of imports in GDP are not clearly different to zero, as discussed in the main text.

Figure C1: Heterogeneity in TFP after tariff reductions

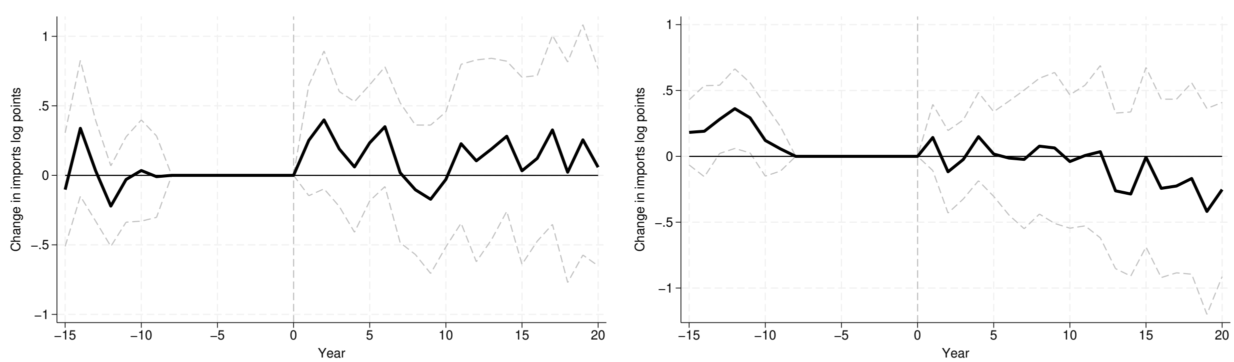


(a) For nonmanufacturer countries

(b) For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.

Figure C2: Heterogeneity in the share of imports in GDP after tariff reductions



(a) For nonmanufacturer countries

(b) For manufacturer countries

Note: The standard errors used for the figure are two-way robust to heteroskedasticity and correlation on the country and year dimensions. Confidence intervals are calculated to the 90% significance level.