MACROECONOMIC CONSEQUENCES OF TARIFFS

Davide Furceri, Swarnali A. Hannan, Jonathan D. Ostry and Andrew K. Rose*

October 2018

Abstract

We study the macroeconomic consequences of tariffs. We estimate impulse response functions from local projections using a panel of annual data that spans 151 countries over 1963-2014. We find that tariff increases lead, in the medium term, to economically and statistically significant declines in domestic output and productivity. Tariff increases also result in more unemployment, higher inequality, and real exchange rate appreciation, but only small effects on the trade balance. The effects on output and productivity tend to be magnified when tariffs rise during expansions, for advanced economies, and when tariffs go up, not down. Our results are robust to a large number of perturbations to our methodology, and we complement our analysis with industry-level data.

JEL Classification Numbers: F13, O11.

Keywords: protection, output, productivity, unemployment, inequality, exchange rate, trade balance.

* Furceri (dfurceri@imf.org), Hannan (sahmed@imf.org), and Ostry (jostry@imf.org) are IMF Research Department; Rose (arose@haas.berkeley.edu) is Berkeley-Haas, ABFER, CEPR and NBER. Key output and the data set are available at http://faculty.haas.berkeley.edu/arose. We are grateful to Charles P. De Cell and Zhangrui Wang for excellent research assistance. The views expressed in this paper are those of the authors and do not necessarily represent the views of the IMF, its Executive Board, or IMF management.

I. Introduction

More than on any other issue, there is agreement amongst economists that international trade should be free.[1] This view dates back to (at least) Adam Smith and is supported by much reasoning. In general, economists believe that freely-functioning markets best allocate resources, at least absent some distortion, externality or other market failure; competitive markets tend to maximize output by directing resources to their most productive uses. Of course, there are market imperfections, but tariffs—taxes on imports—are almost never the optimal solution to such problems. Tariffs encourage the deflection of trade to inefficient producers in order to avoid tariffs, and smuggling to evade tariffs; such distortions reduce welfare. Further, consumers lose more from a tariff than producers gain, so there is "deadweight loss". The redistributions associated with tariffs tend to create vested interests, so harms tend to persist. Broad-based protectionism can also provoke retaliation which adds further costs in other markets. All these losses to output are exacerbated if inputs are protected, since this adds to production costs.

Discussions of market imperfections and the like are naturally microeconomic in nature. Accordingly, most analysis of trade barriers is microeconomic in nature, focusing on individual industries (see Grossman and Rogoff (1995) and references therein). This makes sense. Artificial barriers to international trade have gradually fallen for most countries over the decades since the end of World War II. The exceptions to this trend tend to be concentrated in individual industries, often associated with agriculture or apparel. International commercial policy tends not to be used as a macroeconomic tool, probably because of the availability of superior alternatives such as monetary and fiscal policy. In addition, there are strong theoretical reasons that economists abhor the use of protectionism as a macroeconomic policy; for instance, the broad imposition of tariffs may lead to offsetting changes in exchange rates (Dornbusch, 1974; Edwards, 1989). And while the imposition of a tariff could reduce the flow of imports, it is unlikely to change the trade balance unless it fundamentally alters the balance of saving and investment. Further, economists think that protectionist policies helped precipitate the collapse of international trade in the early 1930s, and this trade shrinkage was a plausible seed of World War II. So, while protectionism *has* not been much used in practice as a macroeconomic policy (especially in advanced countries), most economists also agree that it *should* not be used as a macroeconomic policy.

Times change. Some economies have recently begun to use commercial policy, seemingly for *macroeconomic* objectives. So it seems an appropriate time to study what, if any, the macroeconomic consequences of tariffs have actually been in practice. Most of the predisposition of the economics profession against protectionism is based on evidence that is either a) theoretical, b) micro, or c) aggregate and dated. Accordingly, in this paper, we study empirically the macroeconomic effects of tariffs using recent aggregate data.

Our strategy is to use straightforward methodology that tackles the key issues head-on. We use a transparent approach to allow the data to speak in a straightforward way, allowing us to focus attention on results rather than the estimation technique. We rely on Jorda's (2005) celebrated local projection method to estimate impulse response functions, allowing us as to account flexibly for non-linearities without imposing potentially inappropriate dynamic restrictions.[2] Our panel of annual data is long if unbalanced, covering 1963 through 2014; more recent data is of greater relevance, but older data contains more protectionism. Since little protectionism remains in rich countries, we use a broad span of 151 countries, including 34 advanced and 117 developing countries.

We ask what the effects of changes in tariffs have been on a number of key variables of interest, including output, productivity, unemployment, inequality, the real exchange rate, and the trade balance. Our chief data set is aggregate in nature, but we also use sectoral data, both to probe more deeply and to check the sensitivity of our results. We also explore whether the effects of tariffs depend upon the stage of the business cycle, whether there are asymmetric effects of tariff rises and falls, whether tariff consequences are similar for countries at different stages of development, and so forth.

We study tariffs rather than other types of protectionism for three reasons. First, tariffs are the preferred protectionist policy of rich governments, past and present. Second, tariffs are easier to measure in the aggregate than non-tariff barriers. Third, we try to be conservative when possible, and the costs of tariffs are a lower bound for the costs of protectionism, since non-tariff barriers typically have more costly consequences than tariffs. This conservative strategy also drives our domestic focus. For example, though we are cognizant that Canadian protectionism clearly has effects outside the Great White North, we are most interested in the consequences of Canadian tariffs for Canadian output, productivity, and so forth.

Our results suggest that tariff increases have adverse domestic macroeconomic and distributional consequences. We find empirically that tariff increases lead to declines of output and productivity in the medium term, as well as increases in unemployment and inequality. In contrast, we do not find an improvement in the trade balance after tariffs rise, plausibly reflecting our finding that the real exchange rate tends to appreciate as a result of higher tariffs. The longer-term consequences of tariffs are likely higher than the medium-term effects that we estimate, but we truncate our analysis at the five year horizon to be conservative. Further, we perform considerable sensitivity analysis to demonstrate the robustness of our results.

We take advantage of our panel data set to check the uniformity of our results, and find interesting differences. The medium-term decline in output, following a tariff increase, tends to be more pronounced if the tariff increase is undertaken during an economic expansion. Alternatively, the tariff-induced output increase is smaller following a tariff decrease in a recession, consistent with the view that trade liberalization leads to output losses during periods of weak economic activity, since it induces inter-sectoral shifts. We also find evidence suggesting asymmetric effects of trade protectionism and liberalization; the medium-term output effects associated with a tariff increase are not symmetric to those that follow tariff reduction. Tariff increases also have more adverse effects for advanced economies than for poorer countries.

Our paper relates to several strands of the literature on the impact of trade policies. Earlier studies show that there is no theoretical presumption about the effects of tariffs on output or the trade balance, with the impact depending on a host of factors including the timing and expected duration of the tariff shock, the behavior of real wages and exchange rates, the values of various elasticities, and institutional factors like the exchange rate regime and degree of capital mobility (Ostry and Rose, 1992). More recent work has either focused on understanding the impact of trade liberalization/trade openness on currency movements and the trade balance (Santos-Paulino and Thirlwall, 2004; UNCTAD, 1999; Ju, Wu, and Zeng, 2010; Li, 2004) or on productivity and output (Feyrer, 2009; Alcala and Ciccone, 2004). The impact of trade policies on inequality has been studied in the context of debates about the relative importance of trade and technology in driving inequality (Helpman, 2016) or by using firm-level data to understand the impact of commercial policy on wage inequality (Artuc and McLaren, 2015; Klein, Moser, and Urban, 2010). Compared to this literature, the scope of our paper is ambitious in terms of the data (across both countries and time) and the number of outcome variables explored: we provide a more comprehensive picture of the macroeconomic and distributional effect of tariffs. In addition, while previous studies have looked at the impact of trade liberalization or trade openness, we look only at tariffs—a more narrow variable which may also be more relevant in the current global political context.

We emphasize that our results bolster the case for free trade and seem wholly consistent with conventional wisdom in the discipline. However, that prior is not well-grounded in solid empirical findings, at least at the macro level; filling this gap is the chief objective of this paper. We think this new empirical benchmark helps justify the bent of the discipline towards liberal trade, which is currently based mostly on theoretical grounds, or empirical evidence that is either microeconomic or dated.

II. Empirical Methodology

This section describes the empirical methodology we use to examine the dynamic response of the variables of interest (output, productivity, and so forth), to changes in tariff rates.

Our strategy is to allow the data to speak as clearly as possible, using a reduced-form approach without imposing unreasonable constraints. Our focus is on the macroeconomic consequences of tariff changes, using a broad recent panel of data. We act conservatively in a number of ways, including our focus on purely domestic consequences, and our limited time horizon. Our goal is to establish a plausible set of benchmark results, and then use sensitivity analysis to show that these results are either robust or under-estimates of some of the key protectionist policies currently being pursued.

We use two estimation frameworks. The first is more important; it is applied to country-level data and serves to quantify the macroeconomic effects of tariffs. As a robustness check, the second is applied to sector-level data, and provides insight into the channels through which the effects of tariffs are transmitted, while also addressing some of the limitation of the country-level analysis (by controlling for national macroeconomic shocks that may be correlated with tariff changes).

A. Country-Level Analysis

Our objective is to trace out the response of various outcome variables of interest to tariff changes. Accordingly, we use the well-known local projection method — "LPM" henceforth (Jordà, 2005) — to estimate impulse-response functions. This approach has been advocated by Stock and Watson (2007) and Auerbach and Gorodnichenko (2013), among others, as a flexible choice that does not impose the dynamic restrictions embedded in models like vector autoregressions or autoregressive-distributed lag specifications; it is particularly suited to estimating nonlinearities in the dynamic responses. The baseline regression is specified as follows:

$$y_{i,t+k} - y_{i,t-1} = \alpha_i + \gamma_t + \beta \Delta T_{i,t} + \nu X_{i,t} + \varepsilon_{i,t} \quad (1)$$

where:

- $y_{i,t+k}$ is the outcome variable of interest (log of output, productivity, unemployment rate, Gini coefficient, log real exchange rate, or trade balance/GDP) for country i at time t+k,
- $\{\alpha_i\}$ are country fixed effects to control for unobserved cross-country heterogeneity,
- $\{\gamma_t\}$ are time fixed effects to control for global shocks,
- $\Delta T_{i,t}$ is the change in the tariff rate,
- ν is a vector of nuisance coefficients

- $X_{i,t}$ is a vector of control variables, including two lags of each of: a) changes in the dependent variable, b) the tariff, c) log output, d) the log of real exchange rates and d) the trade balance in percent of GDP, and
- ε is an unexplained (hopefully well-behaved) residual.

The coefficients of greatest interest to us are {β}, the impulse responses of our variables of interest to changes in the tariff rate.[3] We choose our variables of interest to portray arguably the four most important manifestations of the health of the real macroeconomy: GDP, productivity, the unemployment rate, and inequality (the latter measured by the Gini coefficient). We also portray two key transmission mechanisms for tariff shocks, namely the real exchange rate and the balance of trade.

Data Sources

The macroeconomic series for annual GDP, labor productivity (defined as the ratio of GDP to employment), the unemployment rate, real effective exchange rates (period average, deflated by CPI) and the trade balance (period average, deflated by GDP) are taken from IMF WEO and World Bank WDI databases. Data on the Gini coefficient, a measure of inequality, come from the Standardized World Income Inequality Database (SWIID). Table 1 provides a summary of our data sources.

Our tariff series, T, is based on trade tariff rate data at the product level. The main sources are the World Integrated Trade Solution (WITS) and World Development Indicators (WDI); other data sources include: the World Trade Organization (WTO); the General

Agreement on Tariffs and Trade (GATT); and the Brussels Customs Union database (BTN). We aggregate product-level tariff data by calculating weighted averages, with weights given by the export share of each product, measured as fractions of value.

Equation (1) is estimated at the annual frequency for an unbalanced sample of 151 countries from 1964 to 2014. Table 2 provides the list of countries used in the country-level analysis.

B. Industry-level analysis

The empirical specification for industries follows the one used for the analysis on macro data:

$$y_{j,i,t+k} - y_{j,i,t-1} = \alpha_{ij} + \gamma_{it} + \rho_{jt} + \beta^{I}\Delta T_{j,i,t}^{I} + \beta^{O}\Delta T_{j,i,t}^{O} + \nu X_{j,i,t} + \varepsilon_{j,i,t} \qquad (1')$$

where $y_{j,i,t+k}$ is the log of sectoral output (or productivity) for industry *j* in country *i* at time *t+k*; γ_{it} are country-year fixed effects to control for any variation that is common to all sectors of country's economy, including, for instance, aggregate output growth or reforms in other areas; α_{ij} are country-industry fixed effects to control for industry-specific factors, including, for instance, cross-country differences in the growth of certain sectors that could arise from differences in comparative advantages; ρ_{jt} are industry-time fixed effects to control for common factors across countries that can affect specific industries; $T_{j,i,t}^{O}$ and $T_{j,i,t}^{I}$ denote output and input tariffs, respectively; and $X_{j,i,t}$ is a vector of control variables, including two lags of changes in the dependent variables and output and input sectoral tariffs.

The output tariff, $T_{j,i,t}^{O}$ in each sector j is the 2-digit level corresponding tariff rate. Following closely Amiti and Konings (2007) and Topalova and Khandelwal (2011), input tariffs in each sector j are computed as weighted average of output tariffs in all sectors, with weights reflecting the share of imported inputs from each of these sectors used in the production of sector j's total input:

$$T_{j,i,t}{}^{I} = \sum_{k} \theta_{j,i,t} T_{k,i,t}{}^{O}$$

The underlying tariff data is obtained from World Integrated Trade Solution (WITS), while the information on the production structure is taken from OECD's input-output tables.

We match the resulting input and output tariff rates with sectoral-level data (output, value added, employment and productivity) taken from the United Nations Industrial Development Organization (UNIDO) database. This database provides information for 22 manufacturing industries based on the INDSTAT2 2016, ISIC Revision 3.[4] However, to match the sectoral information in the OECD input-output table, we combine some of the sectors in the UNIDO database. The resulting dataset comprise an unbalanced panel with 16 sectors for 39 countries over the period 1991-2014. Tables 3 and 4 provide the list of countries and sectors.

III. RESULTS

A. Aggregate Results

Baseline

Our benchmark aggregate results are presented in Figure 1. Each of the six panels presents the estimated dynamic response for a variable of interest (output, productivity, and so forth) to a one-standard deviation rise in the tariff rate. This is a moderate increase in the tariff rate, of about 3.6 percentage points, that lies well within the standard range of the data.[5] Collectively, the impulse response functions in Figure 1 provide a convenient way to portray the responses of key indicators of the macroeconomy to tariff shocks. Since non-tariff barriers may rise simultaneously, we treat these as conservative estimates of the costs of protectionism. Time is portrayed on the x-axes; the solid lines portray the average estimated response, and we include its 90 percent confidence interval as dotted lines (computed using Driscoll-Kraay standard errors).[6] In another effort to be conservative, we truncate our results five years after the shock.

The results in Panel A suggest that a one standard deviation (or 3.6 percentage point) tariff increase leads to a decrease in output of about .4% five years later. We consider this effect to be plausibly sized and economically significant; it is also significantly different from zero in a statistical sense. Why does output fall after a tariff increase? Panel B indicates that a key channel is the statistically and economically significant decrease in labor productivity, which cumulates to about .9% after five years. Both these key findings make eminent sense; the wasteful effects of protectionism eventually lead to a meaningful reduction in the efficiency with which labor is used, and thus output.[7] Protectionism also leads to a small (statistically marginal) increase in unemployment, as shown in Panel C. Thus the aggregate results for real activity bolster the traditional case against protectionism. So does the evidence on distribution, shown in Panel D; we find that tariff increases lead to more inequality, as measured by the Gini index; the effect becomes statistically significant two years after the tariff change.

To summarize: the aversion of the economics profession to the deadweight losses caused by protectionism seems warranted; higher tariffs seem to have lower output and productivity, while raising unemployment and inequality.

The bottom part of Figure 1 portrays key parts of the transmission mechanism between tariffs and the macroeconomy. As expected, higher tariffs lead to an appreciation of the real exchange rate as shown in Panel E, though the effect is only statistically significantly different from zero in the short term (this is unsurprising, given the noisiness of exchange rates). Panel F shows the net effects of higher tariffs on the trade balance are small and insignificant; absent shifts in saving or investment, commercial policy has little effect on the trade balance.

We consider these results to be reasonable and indeed comforting, at least to the mainstream of the profession; they are quite consistent with conventional wisdom. Still, it is important to examine the generality of our findings, and to see how sensitive they are to the assumptions that we have implicitly made in our analysis. We begin by examining heterogeneity, since three striking and unusual aspects of contemporary protectionism are that tariffs are a) rising, in b) advanced economies, during c) periods of economic expansion.

Tariff Increases vs. Decreases

Thus far, we have implicitly assumed that tariff increases and decreases have symmetric effects. Is this assumption warranted? This is a simple matter to examine, since around 40% of our sample consists of tariff rises (with mean of 1.7ppt and standard deviation of 3.3), while 53% observations consist of tariff falls (with mean of -1.8ppt and standard deviation of 3.4). This variation allows us to test for asymmetry; we extend the baseline specification to allow the response to vary with the sign of the tariff change:

$$y_{i,t+k} - y_{i,t-1} = \alpha_i + \gamma_t + \beta^P D^P_{i,t}\Delta T_{i,t} + \beta^N (1-D^P_{i,t})\Delta T_{i,t} + \nu X_{i,t} + \varepsilon_{i,t} \quad (2)$$

where $D^P_{i,t}$ is a binary variable which is equal to unity when the change in tariff is positive, and zero otherwise.

We present our results on the symmetry of tariff increases and decreases in the top half of Figure 2. The left column presents impulse response functions (estimated from (2) but otherwise similar to those of Figure 1), portraying the effects of tariff increases (in the top row) and decreases (immediately below) on output. The right column is similar, but portrays the response of productivity instead of GDP; we focus on output and productivity since they are two of the most important variables that are plausibly affected by protectionism. To facilitate comparison, the dynamic responses under the assumption of symmetry (estimated with (1), and thus presented in the top row of Figure 1) are also shown as dashed lines.

Manifestly, the decline in output following a one standard deviation *increase* in the tariff rate is higher than the baseline; this effect is statistically significant, as shown in Panel A of Figure 2 for both output and productivity. In contrast, Panel B shows that the effects of a tariff fall on both output and productivity are much smaller. That is, there are asymmetric effects of protectionism; tariff increases hurt the economy more than liberalizations help.

Advanced Economies vs. Emerging Markets & Developing Economies

In exactly the same way, we explore whether the effect of tariffs depend on the income level of the country, since advanced economies tend to use protectionism less than poorer economies.[8] We extend the baseline regression to test for asymmetry depending upon income level:

$$y_{i,t+k} - y_{i,t-1} = \alpha_i + \gamma_t + \beta^{AE} D^{AE}{}_i \Delta T_{i,t} + \beta^{Oth} (1-D^{AE}{}_i)\Delta T_{i,t} + \nu X_{i,t} + \varepsilon_{i,t} \qquad (3)$$

where $D^{AE}{}_{i,}$ is a binary variable which is equal to unity for advanced economies, and zero otherwise. The list of advanced economies follows the IMF classification and is tabulated in Table 5.

Our results appear in the bottom part of Figure 2; the impulse response functions are analogous to those in the top half (which is based on (2)), but for a different split of the data (based on equation 3). An interesting asymmetry emerges; for advanced economies, the decline in output after tariff increases is larger than in the baseline. Panel C shows that output declines by about 1% after four years for advanced economies, compared to the .4% decline in the baseline over the same time horizon. Similarly, the effect on productivity is higher than in the baseline for advanced economies, but lower for other economies.

Recessions vs. Expansions

Does the effect of tariff changes vary with the stage of the business cycle? Trade reforms, insofar as they induce resource shifts between industries, occupations and firms, might lead to larger output losses during slack periods of weak domestic economic activity. To test whether the effect of tariff changes is symmetric between expansions and recessions, we use the following setup, which permits the effect of tariff changes to vary smoothly across different stages of the business cycle:

$$y_{i,t+k} - y_{i,t-1} = \alpha_i + \gamma_t + \beta^L_k F(z_{i,t})_i \Delta T_{i,t} + \beta^H_k (1- F(z_{i,t}) \Delta T_{i,t} + \phi Z_{i,t} + \varepsilon_{i,t} \quad (4)$$

with

$$F(z_{i,t}) = \exp(-\theta z_{i,t})/(1+ \exp(-\theta z_{i,t}), \quad \theta>0,$$

where $z_{i,t}$ is an indicator of the state of the economy (such as GDP growth or unemployment) normalized to have zero mean and unit variance, and Z_{it} is the same set of control variables used in the baseline specification but now also including $F(z_{it})$. F(.) is a smooth transition function used recently by Auerbach and Gorodichencko (2012) to estimate the macroeconomic impact of fiscal policy shocks in expansions as opposed to recessions. This transition function can be interpreted as the probability of the economy being in a recession; $F(z_{it})=1$ corresponds to a deep recession, while $F(z_{it})=0$ corresponds to strong expansion—with the cutoff between expansions and contractions being 0.5. Like Auerbach and Gorodichencko, we use $\theta = 1.5$, which corresponds to assume that the economy spends about 20 percent of times in recessions.[9]

The results from estimating equation (4) for output (in the left column) and productivity (on the right) are presented in Figure 3. We use two different measures of business cycle conditions; the panels at the top use GDP growth, while those below are based on the unemployment rate. For each indicator of the business cycle, impulse response functions for expansions are presented immediately above those for recessions. Since the results from the two different indicators of the business cycle are similar, we concentrate on the top four panels, which use GDP growth as a business cycle measure.

The results in Figure 3 suggest that the response of both output and productivity to rises in the tariff is more dramatic during expansions. When tariffs increase by a standard deviation and the economy is enjoying good times, the medium-term loss in output is higher than the baseline by about 1%; the productivity decline is also larger. Consistently, tariff increases during recession seem to *increase* output and productivity in the medium-term, though the effects are not statistically significant; protection during recessions may have a mild stimulating effect.[10]

Overall, we find that tariff changes have more negative consequences for output and productivity when tariffs a) increase (rather than decrease), for b) advanced economies (not emerging markets and developing economies), during c) good economic conditions. While more work needs to be done to understand the channels for these effects better, they do not bode well for the present protectionist climate.[11]

Robustness Checks[12]

The previous sub-section analyzed the heterogeneous effects of tariffs on output and productivity. This section is complementary; it presents several robustness checks to demonstrate the generality of our results. We provide three types of checks, changing: a) our key regressor; b) our estimation technique (we are especially concerned with endogeneity); and c) our sample. This sensitivity analysis is presented in a series of fifteen IRFS, which are presented for output and productivity respectively in Figures 4 and 5.[13]

Consider Figure 4, which presents the robustness checks for output (Figure 5 is analogous for productivity). Our default results are presented in the top-left panel of the figure to facilitate comparison. In the two other top panels, we transform our key regressor, tariffs. In the top-middle panel, we examine whether the results hold when considering tariff changes in percentage (that is, dividing our baseline measure by the lagged level of tariff), rather than absolute terms. In the top-right panel, we substitute the lag of tariffs for its contemporaneous value. In both (and indeed all) panels, the default response and its confidence interval (taken from the top-left) is plotted; the mean response for the perturbation is plotted with a thick black line. If it lies within the confidence interval and is relatively close to the dashed line, we consider our results to be robust.

Clearly, the exact way we transform the tariff regressor has little effect on the results. The IRFs for our different transformations of tariffs indicate that the output response to changes in tariff are not statistically different from those reported in the baseline: in both cases, these responses lie well inside the confidence bands of the baseline responses.

Estimation Sensitivity

Our specification implicitly assumes that shocks to the tariff do not respond to changes in the outcome variables within a year. To check whether the results are sensitive to this assumption, we use three alternative estimation techniques. First, we perform a VAR analysis, using a Cholesky decomposition with the following order to recover orthogonal shocks: the change in the log of output (or productivity), the change in tariff, the change in log of real exchange rate and the change in trade balance (in percent of GDP).[14] Next, we modify equation (1) by controlling for the contemporaneous changes in the trade balance and the real exchange rate—this is equivalent to considering shocks to the tariff that are orthogonal to contemporaneous shocks in these variables.[15,16] Another possible concern is that countries implement tariff changes because of concerns regarding future weak economic growth. To address this issue, we estimate a specification that controls for past growth as well as for expected at *t-1* of future GDP growth rates (using IMF WEO forecasts). These three perturbations are presented in the second row of Figure 4, and do not fundamentally change our conclusions.

To address the endogeneity concerns further, we implement an instrumental variable (IV) approach. As an instrument, we use the weighted-average of changes in the tariff in major (top 5) trading-partner countries, where the weights are determined by the strength of trade linkages with other countries. Specifically, the instrument is computed as follows:

$$I_{i,t} = \sum_{j=1,5\ (j \neq i)} \Delta T_{j,t}\, w_{i,j,t} \tag{5}$$

where $I_{i,t}$ is the instrument of tariff for country *i* at time t; $\Delta T_{j,t}$ is the change in the tariff for country *j* (up to the 5 largest trading partners) at time *t*; and $w_{i,j,t}$ is the share of total exports and imports between country i and country j in the total exports and imports for country *i*: $\frac{Export_{i,j,t}+Import_{i,j,t}}{Export_{i,t}+Import_{i,t}}$.

The first-stage estimates suggest that this instrument is "strong" and statistically significant (see Appendix III for details).[17] In addition, we consider the instrument to be plausibly exogenous, since changes in the tariff in major (top 5) trading-partner countries are unlikely to be correlated with the error term of Equation (1), once we control for lagged changes in domestic macroeconomic variables (output, real exchange rates, tariff and trade balance). We perform exclusion-restriction tests and find that tariff changes in major trading partners do not have any effect on output or other outcome variables of interest in country *i* if not through tariff changes in country *i*.[18]

Our IV results are presented in the middle-left panel. The IV technique is noisier than our default technique but leads to an even larger decline in output within five years.

To be conservative, we stick with our default technique. But the important message is that our results do not evaporate with different estimation techniques.

Sample Sensitivity

In our final set of aggregate results, we check the robustness of the results to a number of perturbations to the sample size. We change our sample of data in eight ways: a) we drop series with gaps and less than 20 consecutive years; b) we drop high inflation episodes (inflation above 100 percent); c) we drop small countries (with population below a million); d) we drop outliers (those observations corresponding to the residuals in the output regression in the bottom and top 1st percentiles of the distribution)[19]; e) we restrict the time sample to years after 1979; f) we drop high tariff episodes (those with tariff rates above 66 percent—corresponding to the 99th percentile of the distribution); g) we drop observations from the Americas; and h) we drop Asian and Sub-Saharan African economies. Our results persist through all these perturbations.

We conclude that our results are reasonably robust.

Industry-level results

Our analysis thus far has shown that increases in tariffs lead, on average, to declines in output and productivity in the medium term. This section explores the role of sectoral input and output tariffs in shaping the aggregate effect of protectionism. Before turning to the estimated effects, it is useful to note the effect on aggregate value added of a tariff increase in sector j can be expressed (in the absence of output spillovers across sectors) as the sum of two components, the effect of the tariff increase on the value added of sector j (that is, the output tariff effect) and its effect on the value added of all remaining sectors (that is, effects through the input channel):

$$\frac{dY_t}{dT_{j,t}} = \frac{dY_{j,t}}{dT_{j,t}} + \sum_{s \neq j} \frac{dY_{s,t}}{dT_{j,t}} \tag{6}$$

The four panels of Figure 6 show the estimated dynamic responses of sectoral output (on the left) and productivity (on the right) to one-standard deviation increases in input tariffs (above, equivalent to an increase of about 0.4 ppt) and output tariffs (below, equivalent to a 2.0 ppt increase). As always, we portray results for the five years following the tariff change, and include 90 percent confidence intervals around the point estimate (computed using Driscoll-Kraay standard errors for the estimated coefficients).

The results in the top panels of Figure 6 suggest that an increase in the input tariff rate leads to a statistically significant decline in sectoral output of about 6.4% five years after the tariff hike. It also results in a statistically significant decline in productivity (shown to the right) of about 3.9% five years after the tariff hike, and again the effect is statistically significant.

While input tariff increases lead to declines in output and productivity, increases in output tariffs have a statistically positive impact on output, with output increasing by 3.1 percent in five years. The impact on productivity is positive but not statistically significant.[20]

To summarize, these results suggest that the negative macroeconomic effect of tariff increases presented in the previous section stems largely from increases in input tariffs.

IV. Conclusion

A specter is haunting the international economy: the specter of a trade war. Well, the specter of a trade war is at least haunting economists. It is striking that the distaste for protectionism felt by the discipline is not shared by the wider public. Modern economics began over two hundred years ago in part as an intellectual exercise against mercantilism, so it is worrying that the profession has been unable to persuade the public of the merits of free trade. But perhaps some of the public's mild views on protectionism stem from the fact that most economic analysis of protectionism is theoretical, microeconomic, or dated?

In this paper, we examine the macroeconomic consequence of tariffs. We use impulse response functions from local projections on a panel of annual data spanning 151 countries over 1963-2014. The main analysis on aggregate data is complemented with industry-level data.

Our results suggest that tariff increases have an adverse impact on output and productivity; these effects are economically and statistically significant. They are magnified when tariffs rise during expansions, for advanced economies, and when tariffs go up. We also find that that tariff increases lead to more unemployment and higher inequality, further adding to the deadweight losses of tariffs. Tariffs have only small effects on the trade balance though, in part because they induce offsetting exchange rate appreciations.

All this seems eminently sensible and bolsters the arguments that mainstream economists make against tariffs; our results can be regarded as strong empirical evidence for the benefits of liberal trade. And given the current global context, we take special note of the negative consequences when advanced economies increase tariffs during cyclic upturns.

Finally, the limitations in our approach should be borne in mind when interpreting our estimates. Though our data set contains a fair number of tariff increases, it is drawn from the postwar period which is mostly characterized by trade liberalization. While we use an instrumental variable approach to address endogeneity, it is difficult to mitigate such concerns completely. At the same, the host of robustness checks and the industry-level analysis should provide some comfort, particularly for output and productivity. We also stress that we have tried throughout to be conservative. For instance, our results on tariff increases are likely understated since they do not consider the effects from retaliation.

V. References

Ahn, Jaebin, Era Dabla-Norris, Romain Duval, Binjie Hu, and Lamin Njie, 2016, "Reassessing the Productivity Gains from Trade Liberalization," IMF Working Paper, WP/16/77.

Alcala, F., and A. Ciccone, 2004, "Trade and Productivity," The Quarterly Journal of Economics, vol. 119(2), pp. 613-646.

Amiti, Mary, and Jozef Konings, 2007, "Trade Liberalization, Intermediate Inputs, and Productivity: Evidence from Indonesia," *American Economic Review,* vol. 97(5), pp. 1611-1638.

Artuç, E., and McLaren, J. 2015. "Trade Policy and Wage Inequality: A Structural Analysis with Occupational and Sectoral Mobility," *Journal of International Economics*, vol. 97(2), pp. 278-294.

Auerbach, Alan J., and Yuriy Gorodnichenko, 2012, "Measuring the Output Responses to Fiscal Policy," *American Economic Journal,* vol. 4(2), pp. 1-27.

Auerbach, Alan J., and Yuriy Gorodnichenko, 2013, "Output Spillovers from Fiscal Policy," *American Economic Review: Papers and Proceedings,* vol. 103(3), pp. 141-146.

Dornbusch, Rudiger, 1974, "Tariffs and Nontraded Goods," *Journal of International Economics,* vol. 4(2), pp. 177-85.

Edwards, Sebastian, 1989, Real Exchange Rates, Devaluation, and Adjustment (Cambridge, Massachusetts: MIT Press).

Feyrer, J., 2009, "Distance, Trade, and Income – The 1967 to 1975 Closing of the Suez Canal as a Natural Experiment," NBER Working Paper No. 15557.

Granger, Clive W. J., and Timo Terasvirta, 1993, Modelling Nonlinear Economic Relationships (New York: Oxford University Press).

Grossman, Gene M., and Kenneth Rogoff, 1995, Handbook of International Economics, Volume III (Amsterdam: Elsevier Science Publishers B.V.).

Helpman, E., 2016, "Globalization and Wage Inequality," NBER Working Paper No. 22944.

Jorda, Oscar, 2005, "Estimation and Inference of Impulse Responses by Local Projections," *American Economic* Review, vol. 95(1), pp. 161-182.

Ju, Jiandong, Yi Wu and Li Zeng, 2010, "The Impact of Trade Liberalization on the Trade Balance in Developing Countries," IMF Staff Papers, vol. 57(2), pp. 427-449.

Klein, M. W., Moser, C., and Urban, D. M. 2010. "The Contribution of Trade to Wage Inequality: The Role of Skill, Gender, and Nationality," NBER Working Paper 15985.

Li, Xiangming, 2004, "Trade Liberalization and Real Exchange Rate Movement," IMF Staff Papers, vol. 51(3), pp. 553-584.

Ostry, Jonathan D., and Andrew K. Rose, 1992, "An Empirical Evaluation of the Macroeconomic Effects of Tariffs," *Journal of International Money and Finance*, vol. 11, pp. 63-79.

Rose, Andrew K., 2013, "Protectionism isn't Counter-Cyclic (anymore)," *Economic Policy,* vol. 28(76), pp. 569-612.

Santos-Paulino, Amelia U., and A.P. Thirlwall, 2004, "The Impact of Trade Liberalisation on Exports, Imports, and the Balance of Payments of Developing Countries," *Economic Journal,* vol. 114, pp. 50-72.

Stock, James, and Mark Watson, "Why Has U.S. Inflation Become Harder to Forecast?" *Journal of Money, Banking and Credit,* vol. 39(1), pp. 3-33.

Topalova, Petia, and Amit Khandelwal, 2011, "Trade Liberalization and Firm Productivity: The Case of India," *The Review of Economics and Statistics,* vol. 93(3), pp. 995-1009.

UNCTAD, 1999, Trade and Development Report (Geneva, UNCTAD).

Table 1. Data Sources for Country-level Analysis

Indicator	Source
Total employment (persons, millions)	World Economic Outlook (WEO)
Unemployment rate (percent)	WEO and World Development Indicators from World Bank (WDI)
Gross Domestic Product in constant prices (national currency, billions)	WEO and WDI
Growth of Real GDP Exp. In Current Oct. Pub. (%)	WEO
Real effective exchange rate (2010=100)	Information Notice System (IMF)
Gini net mean of 100	The Standardized World Income Inequality Database (SWIID)
Tariff rates	Sructural Reform database, IMF (forthcoming). Main sources are the WITS, WDI, WTO, GATT, BTN (Brussels Customs Union database)
Trade balance as a share of GDP; Trade balance is computed using exports of goods and services, and imports of goods and services. Exports, imports and GDP are in constant prices (national currency, billions)	WEO and WDI
Instruments for tariff	Author calculation using data from WDI and IMF Direction of Trade Statistics

Table 2. List of Countries in Country-level Analysis

Albania	China	Hungary	Moldova	Singapore
Algeria	Colombia	Iceland	Mongolia	Slovak Republic
Angola	Comoros	India	Montenegro, Rep. of	Slovenia
Antigua and Barbuda	Congo, Republic of	Indonesia	Morocco	South Africa
Argentina	Costa Rica	Iran	Mozambique	Spain
Armenia	Croatia	Ireland	Myanmar	Sri Lanka
Australia	Cyprus	Israel	Namibia	St. Lucia
Austria	Czech Republic	Italy	Nepal	Swaziland
Azerbaijan	Cote d'Ivoire	Jamaica	Netherlands	Sweden
Bahrain	Denmark	Japan	New Zealand	Taiwan Province of China
Bangladesh	Dominica	Jordan	Nicaragua	Tanzania
Barbados	Dominican Republic	Kazakhstan	Niger	Thailand
Belarus	Ecuador	Kenya	Nigeria	Togo
Belgium	Egypt	Korea	Norway	Tonga
Belize	El Salvador	Kuwait	Oman	Trinidad and Tobago
Benin	Estonia	Kyrgyz Republic	Pakistan	Tunisia
Bolivia	Ethiopia	Lao P.D.R.	Panama	Turkey
Bosnia and Herzegovina	Finland	Latvia	Papua New Guinea	Turkmenistan
Botswana	France	Lebanon	Paraguay	Uganda
Brazil	Gabon	Lithuania	Peru	Ukraine
Brunei Darussalam	Gambia, The	Luxembourg	Philippines	United Arab Emirates
Bulgaria	Germany	Macedonia, FYR	Poland	United Kingdom
Burkina Faso	Ghana	Madagascar	Portugal	United States
Burundi	Greece	Malawi	Qatar	Uruguay
Cabo Verde	Guatemala	Malaysia	Romania	Uzbekistan
Cambodia	Guinea	Mali	Russia	Vanuatu
Cameroon	Guinea-Bissau	Malta	Rwanda	Venezuela
Canada	Haiti	Mauritania	Saudi Arabia	Vietnam
Central African Republic	Honduras	Mauritius	Senegal	Yemen
Chad	Hong Kong SAR	Mexico	Sierra Leone	Zambia
Chile				

Table 3. List of Countries in Industry-level Analysis

United States	South Africa
United Kingdom	Cyprus
Austria	Indonesia
Belgium	Korea
Denmark	Philippines
France	Vietnam
Germany	Morocco
Italy	Bulgaria
Luxembourg	Russia
Netherlands	China
Sweden	Czech Republic
Canada	Slovak Republic
Finland	Estonia
Greece	Latvia
Ireland	Hungary
Malta	Lithuania
Portugal	Slovenia
Spain	Poland
Australia	Romania
New Zealand	

Table 4. List of Industries

Food products, beverages and tobacco
Textiles, textile products, leather and footwear
Wood and products of wood and cork
Pulp, paper, paper products, printing and publishing
Coke, refined petroleum products and nuclear fuel
Chemicals and chemical products
Rubber and plastics products
Other non-metallic mineral products
Basic metals
Fabricated metal products
Machinery and equipment, nec
Computer, Electronic and optical equipment
Electrical machinery and apparatus, nec
Motor vehicles, trailers and semi-trailers
Other transport equipment
Manufacturing nec; recycling

Table 5. List of Advanced Economies in Country-Level Analysis

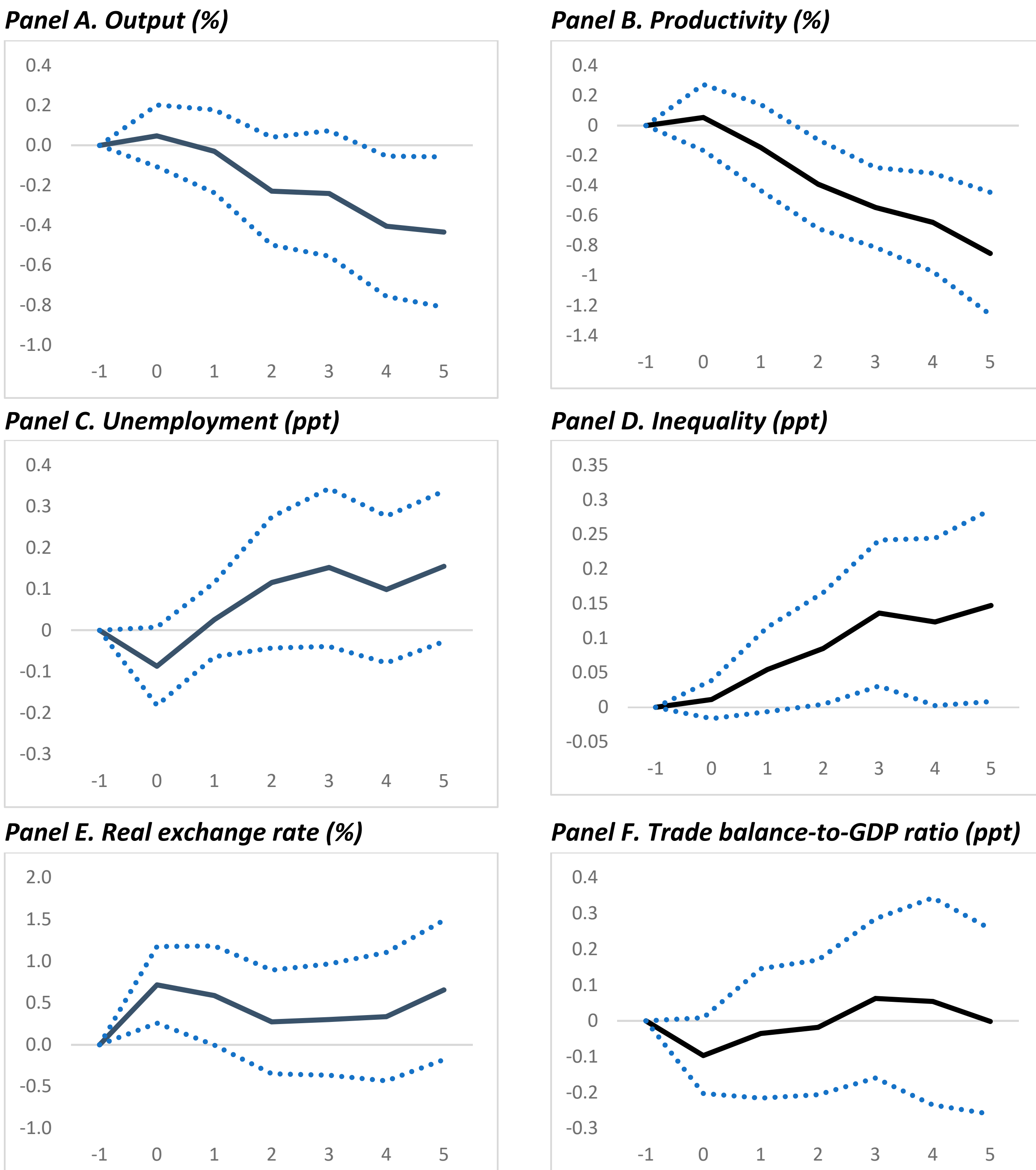
Australia	Japan
Austria	Korea
Belgium	Latvia
Canada	Luxembourg
Cyprus	Malta
Czech Republic	Netherlands
Denmark	New Zealand
Estonia	Norway
Finland	Portugal
France	Singapore
Germany	Slovak Republic
Greece	Slovenia
Hong Kong SAR	Spain
Iceland	Sweden
Ireland	Taiwan Province of China
Israel	United Kingdom
Italy	United States

Table 6. The Aggregate and Distributional Effects of Tariffs

	A	B	C	D	E	F
(Cumulative) Impact on Dependent Variables *t* Years after Tariff Shock	**Output (%)**	**Real exchange rate (%)**	**Trade balance (ppt)**	**Productivity (%)**	**Unemployment (ppt)**	**Inequality (ppt)**
t = 0	0.013	0.196**	-0.02657	0.015	-0.02384	0.00308
	-0.026	-0.076	(0.01759)	-0.037	(0.01578)	(0.00460)
t = 1	-0.008	0.161	-0.00964	-0.040	0.00707	0.01498
	-0.035	-0.099	(0.03011)	-0.048	(0.01496)	(0.01017)
t = 2	-0.063	0.075	-0.00492	-0.107**	0.03176	0.02332*
	-0.045	-0.103	(0.03135)	-0.049	(0.02646)	(0.01344)
t = 3	-0.066	0.083	0.01719	-0.150***	0.04171	0.03732**
	-0.052	-0.111	(0.03704)	-0.044	(0.03187)	(0.01756)
t = 4	-0.111*	0.092	0.01488	-0.177***	0.02708	0.03380
	-0.059	-0.128	(0.04820)	-0.055	(0.02963)	(0.02017)
t = 5	-0.119*	0.180	-0.00042	-0.234***	0.04248	0.04030*
	-0.063	-0.139	(0.04308)	-0.068	(0.03035)	(0.02311)
Average number of observations	3468	3354	3466	2217	1350	2331
Average number of countries	148	147	148	102	86	128

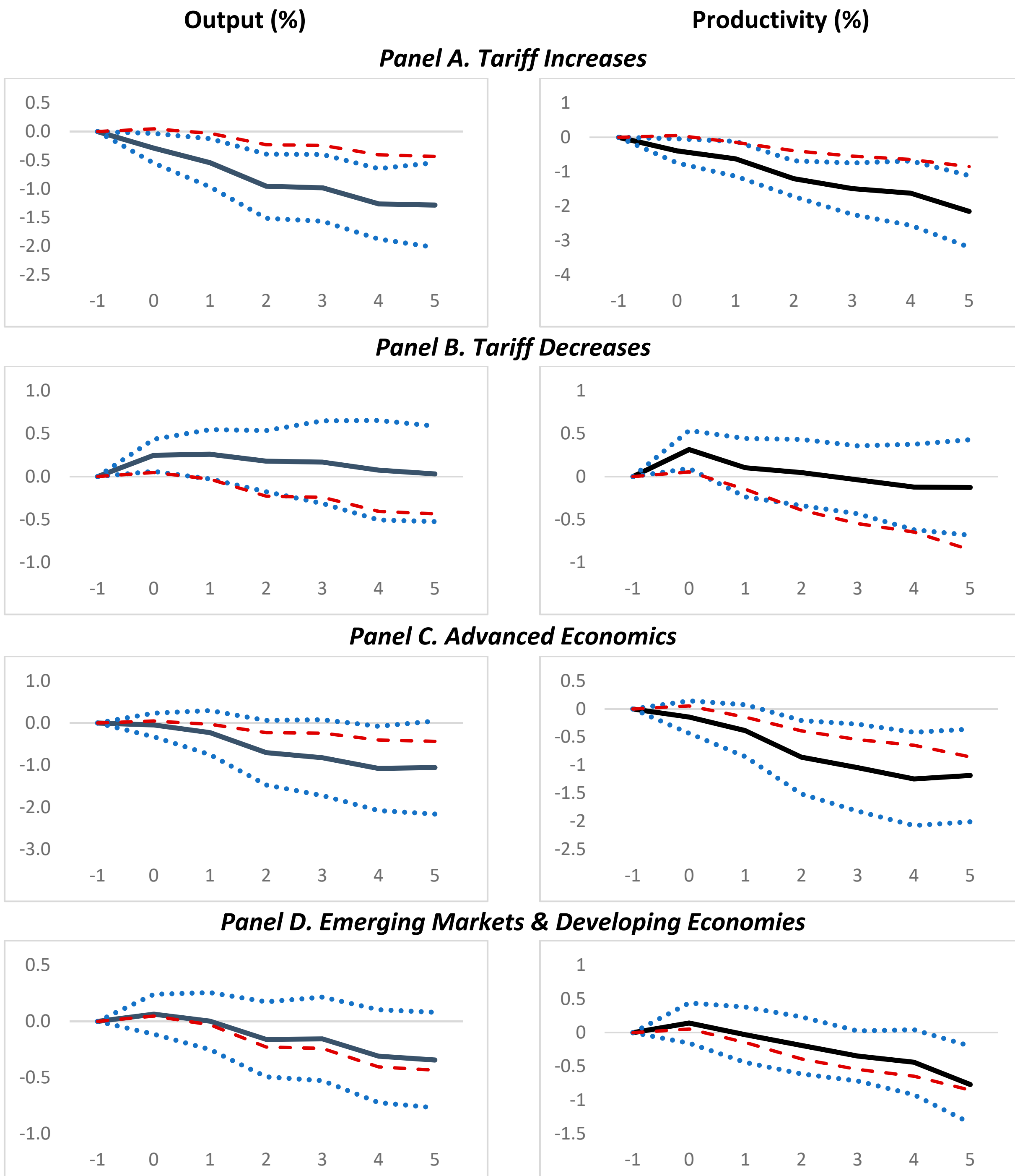
Note: Standard errors are reported in parenthesis. ***, **, and * denote significance at 1 percent, 5 percent, and 10 percent, respectively. Estimates based on equation (1).

Figure 1. The Effect of Tariffs



Note: The solid line indicates the response of output (real exchange rate, trade balance, labor productivity, unemployment, inequality) to a one standard deviation increase in tariff; the dotted lines correspond to 90% confidence bands. The x-axis denotes time. t=0 is the year of the change. The estimates are based on equation (1).

Figure 2. The Effect of Tariffs—Tariff Increases vs. Decreases; Advanced Economies vs. Emerging Markets & Developing Economies

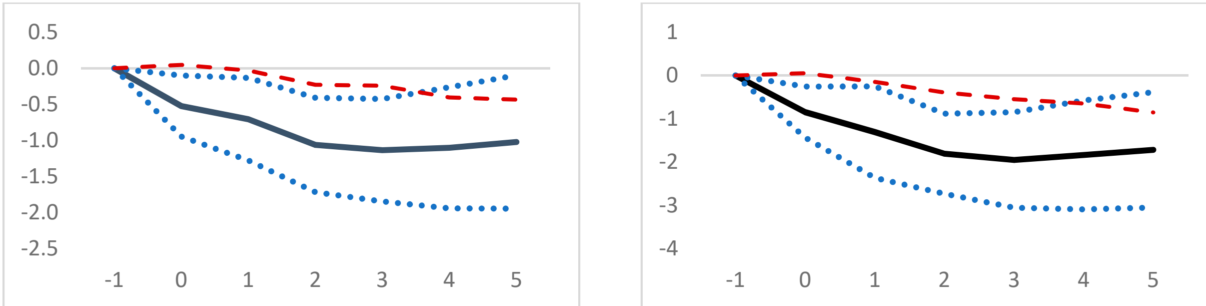


Note: The solid black line indicates the response of output (productivity) to a one standard deviation increase and decrease in tariff (advanced economies and emerging markets & developing economies); the dotted lines correspond to 90% confidence bands; estimates for Panel A and B are based on equation (2); estimates for Panel C and D are based on equation (3). Dashed red lines indicate the response of output (productivity) to a one standard deviation increase in tariff in the baseline; estimates based on equation (1). The x-axis denotes time. t=0 is the year of the tariff change.

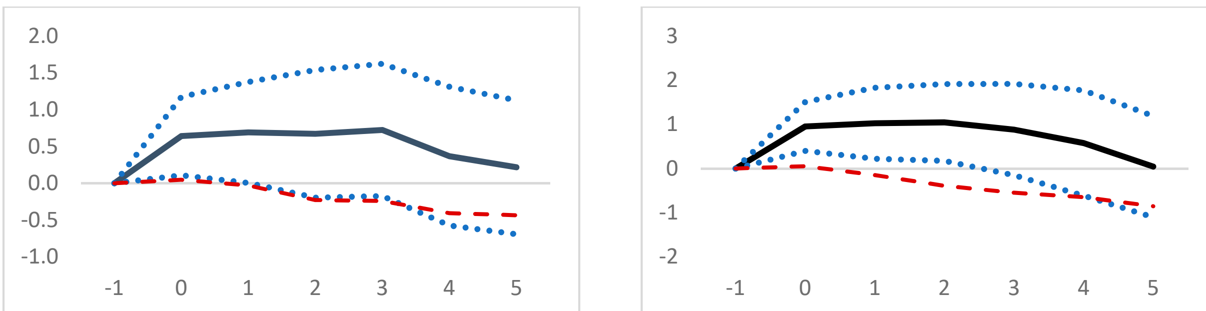
Figure 3. The Effect of Tariffs—Expansions vs. Recessions

Output (%) **Productivity (%)**

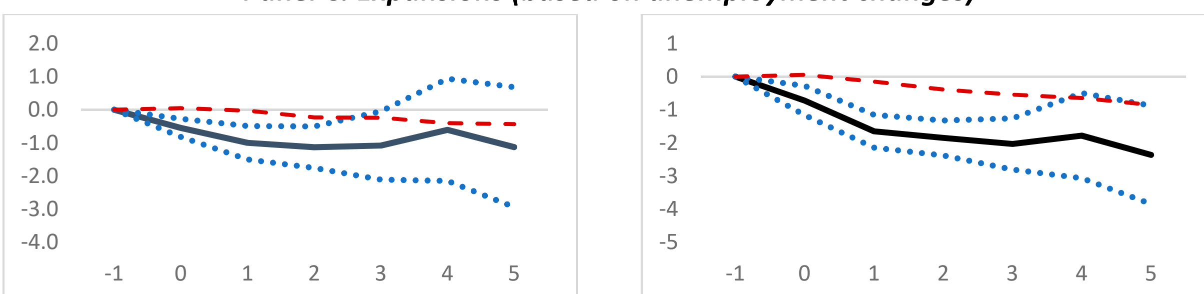
Panel A. Expansions (based on GDP growth)



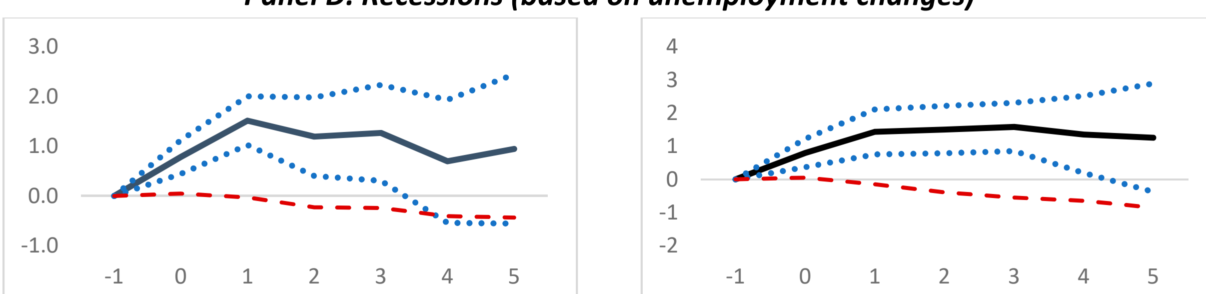
Panel B. Recessions (based on GDP growth)



Panel C. Expansions (based on unemployment changes)

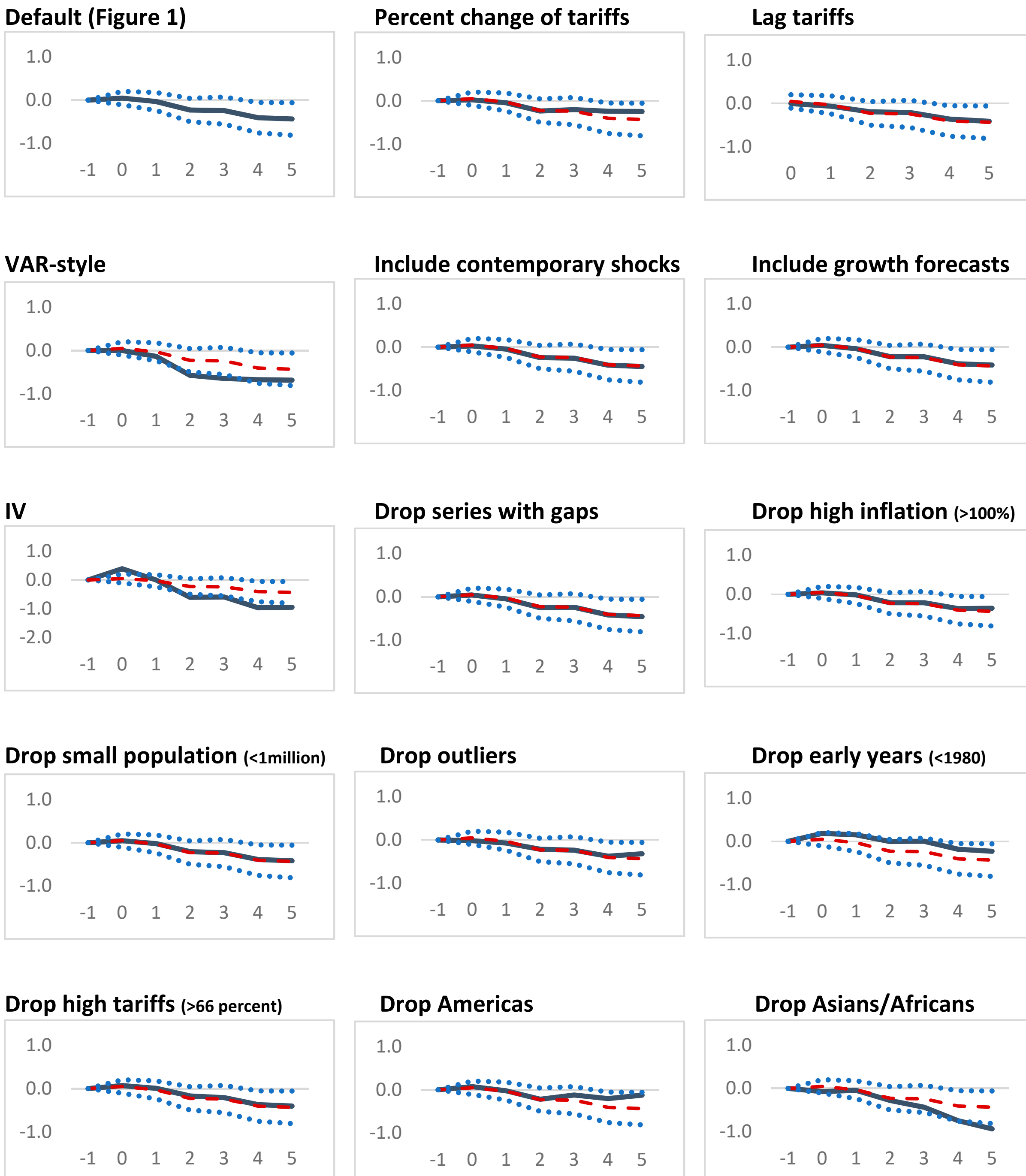


Panel D. Recessions (based on unemployment changes)



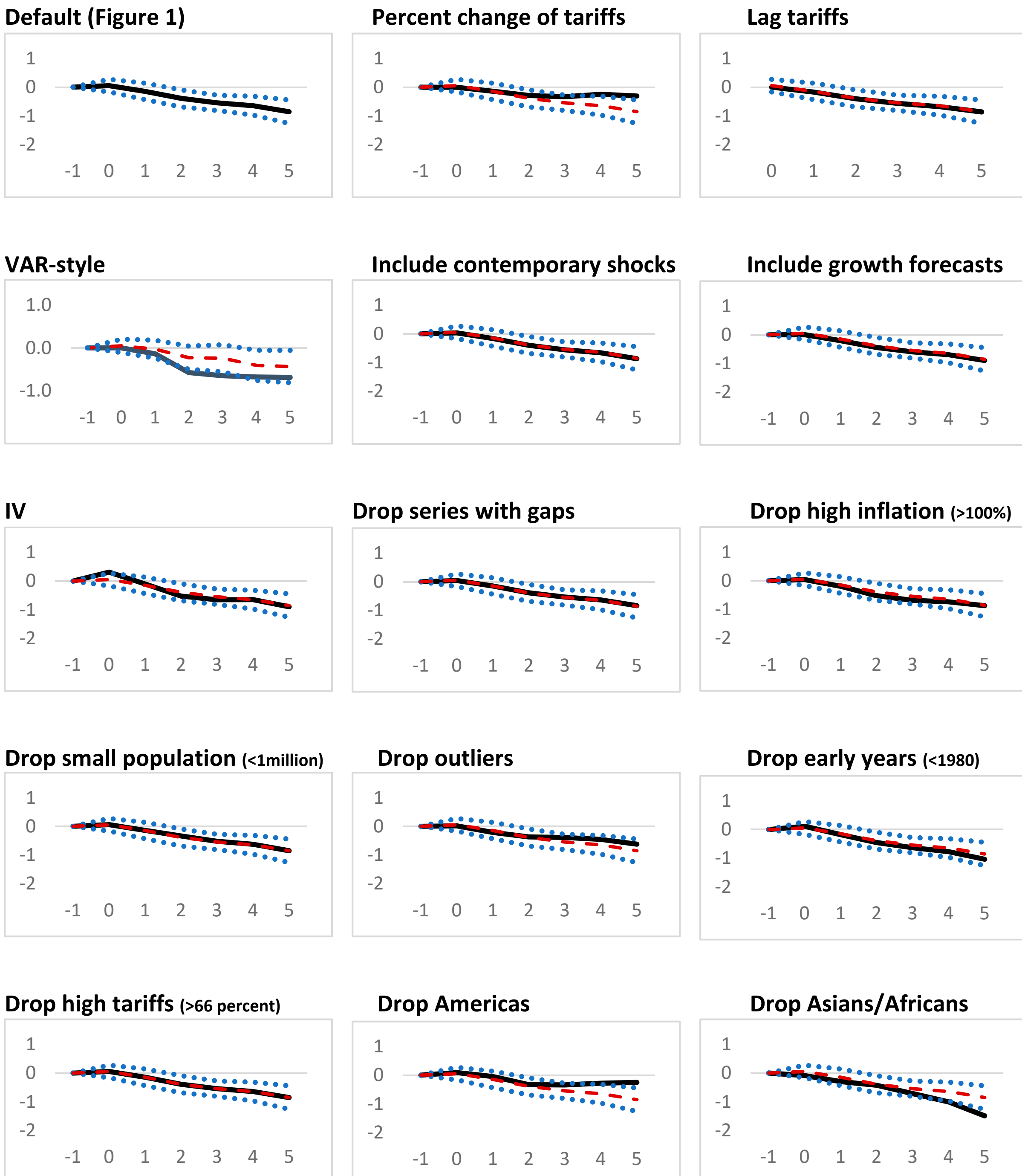
Note: The solid black line indicates the response of output (productivity) to a one standard deviation increase in tariff during expansions and recessions; the dotted lines correspond to 90% confidence bands; estimates based on equation (4); for Panel A and B expansions and recessions are identified using GDP growth; for Panel C and D using unemployment changes. Dashed red lines indicate the response of output (productivity) to a one standard deviation increase in tariff in the baseline; estimates based on equation (1). The x-axis denotes time. t=0 is the year of the tariff change.

Figure 4. Robustness for Output



Note: The black solid line indicates the response of output to a one standard deviation increase in tariff using the scenarios described in each title of the chart. The red dotted line represents the baseline results, estimated based on equation (1). The blue dotted lines correspond to 90% confidence bands of the baseline. The x-axis denotes time. t=0 is the year of the change.

Figure 5. Robustness for Productivity

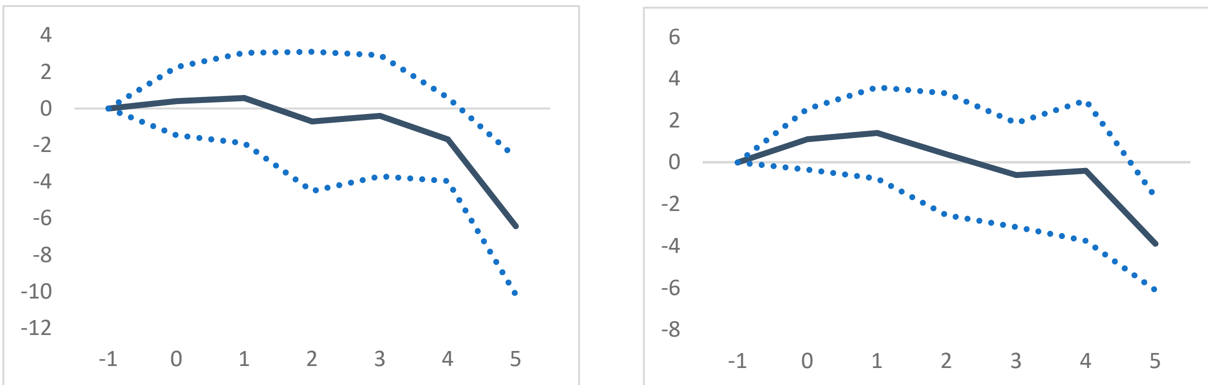


Note: The black solid line indicates the response of productivity to a one standard deviation increase in tariff using the scenarios described in each title of the chart. The red dotted line represents the baseline results, estimated based on equation (1). The blue dotted lines correspond to 90% confidence bands of the baseline. The x-axis denotes time. t=0 is the year of the change.

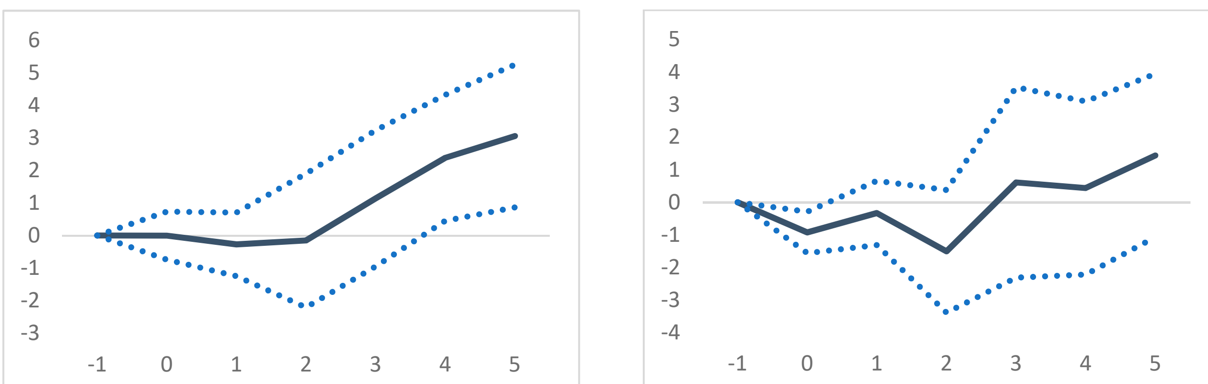
Figure 6. The Effect of Tariffs using Industry-level Data

Output (%) **Productivity (%)**

Panel A. The Effect of Input Tariffs



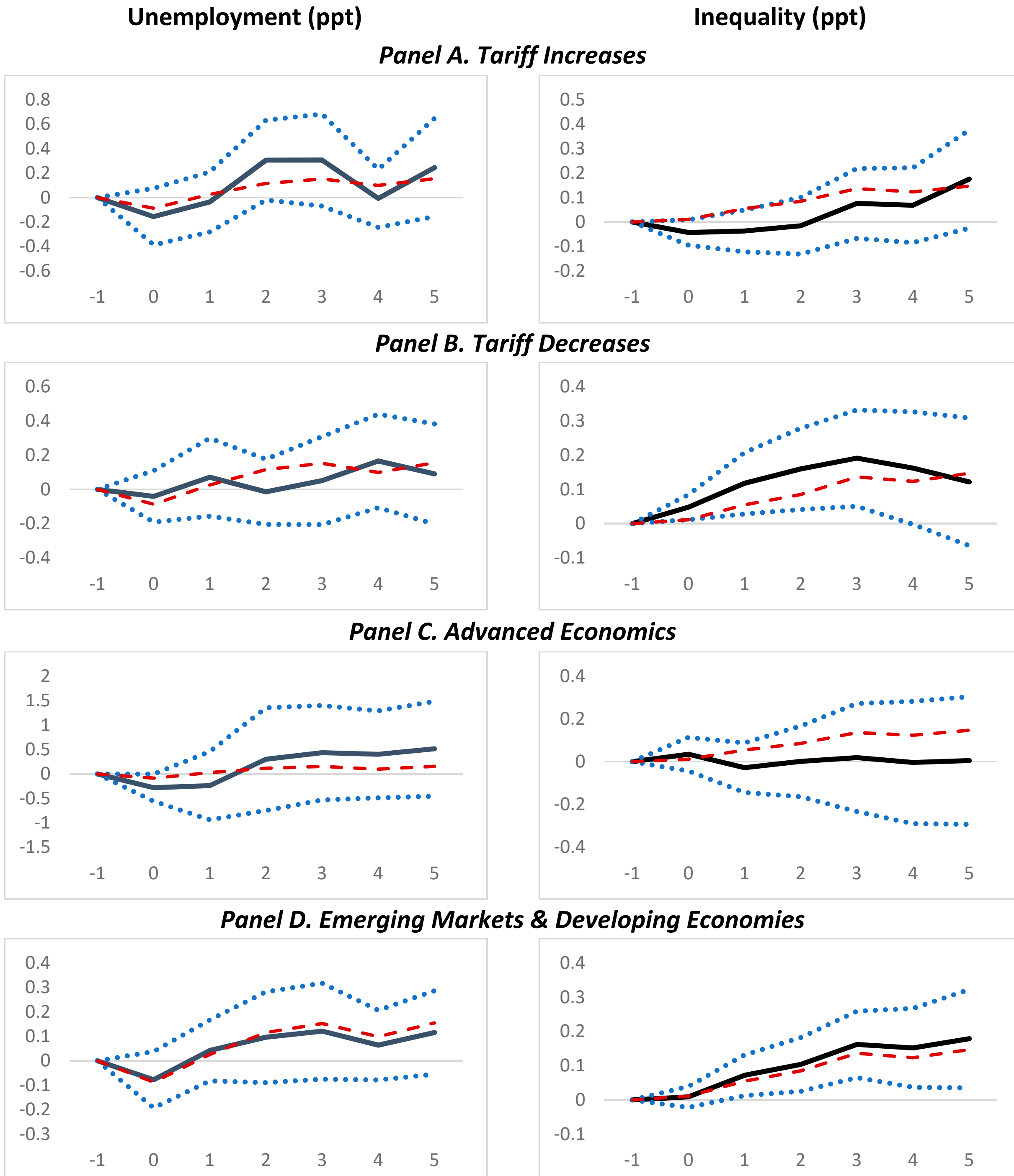
Panel B. The Effect of Output Tariffs



Note: The solid line indicates the response of output/labor productivity to a one standard deviation increase in input/output tariff; the dotted lines correspond to 90% confidence bands. The x-axis denotes time. t=0 is the year of the change. The estimates are based on equation (1’).

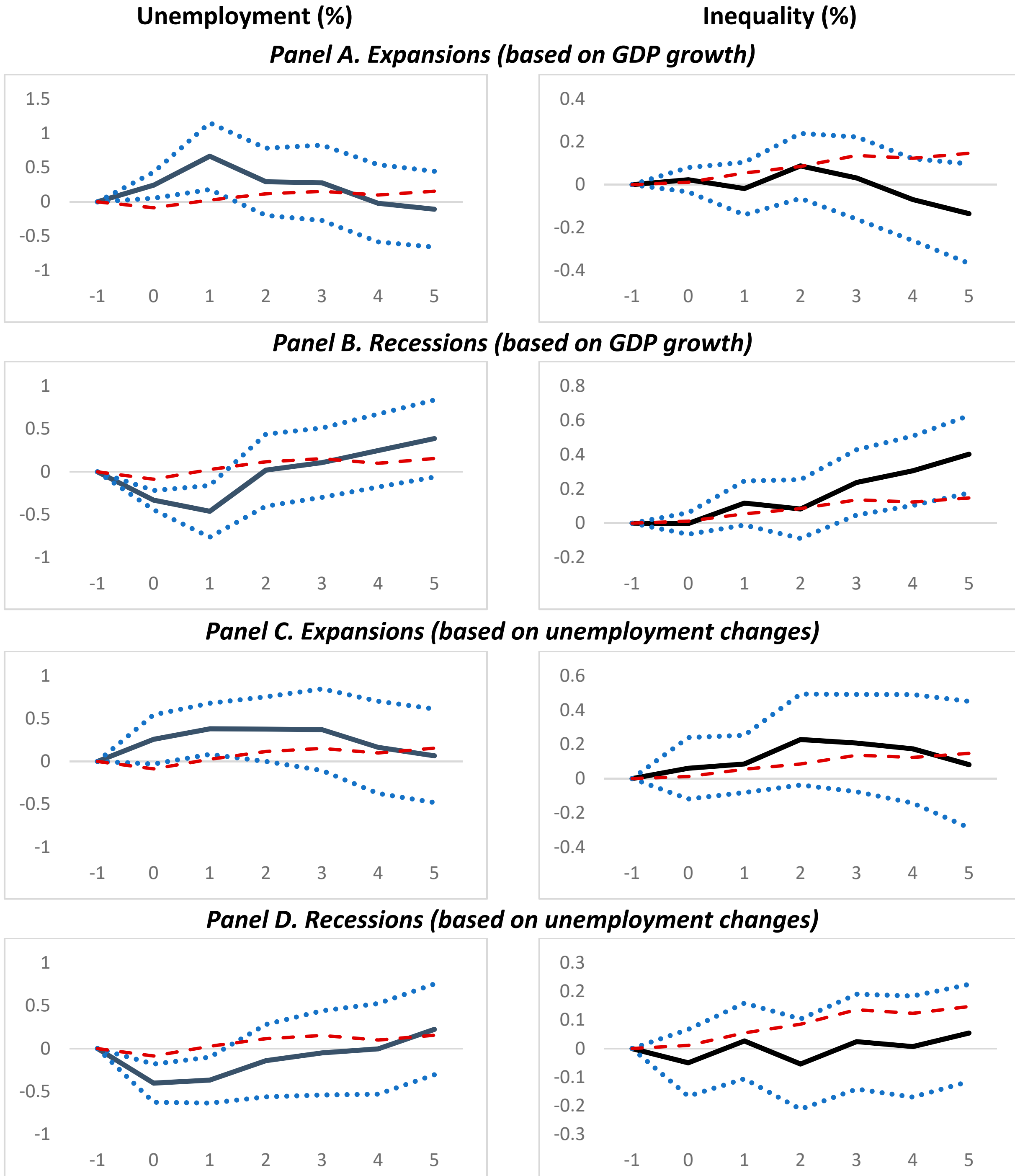
VI. Appendix I—Results for Unemployment, Inequality, Real exchange rate, and Trade balance

Figure AI.1. The Effect of Tariffs—Tariff Increases vs. Decreases; Advanced Economies vs. Emerging Markets & Developing Economies



Note: The solid black line indicates the response of unemployment (inequality) to a one standard deviation increase and decrease in tariff (advanced economies and emerging markets & developing economies); the dotted lines correspond to 90% confidence bands; estimates for Panel A and B are based on equation (2); estimates for Panel C and D are based on equation (3). Dashed red lines indicate the response of unemployment (inequality) to a one standard deviation increase in tariff in the baseline; estimates based on equation (1). The x-axis denotes time. t=0 is the year of the tariff change.

Figure AI.2. The Effect of Tariffs—Expansions vs. Recessions

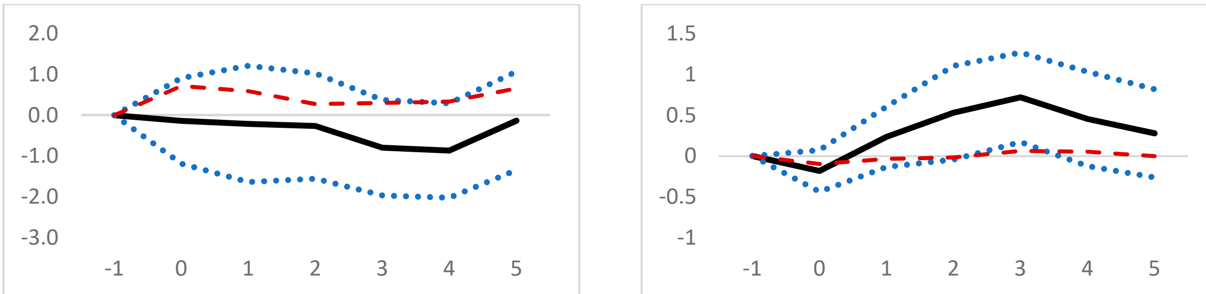


Note: The solid black line indicates the response of unemployment (inequality) to a one standard deviation increase in tariff during expansions and recessions; the dotted lines correspond to 90% confidence bands; estimates based on equation (4); for Panel A and B expansions and recessions are identified using GDP growth; for Panel C and D using unemployment changes. Dashed red lines indicate the response of unemployment (inequality) to a one standard deviation increase in tariff in the baseline; estimates based on equation (1). The x-axis denotes time. t=0 is the year of the tariff change.

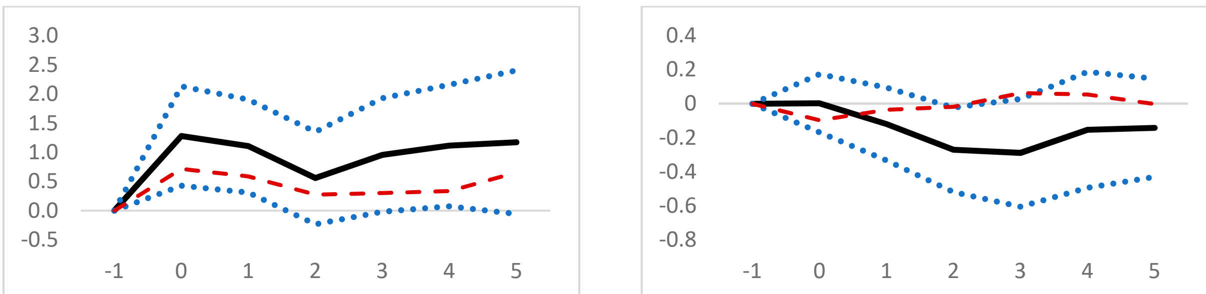
Figure AI.3. The Effect of Tariffs—Tariff Increases vs. Decreases; Advanced Economies vs. Emerging Markets & Developing Economies

Real exchange rate (%) ***Trade balance-to-GDP ratio (ppt)***

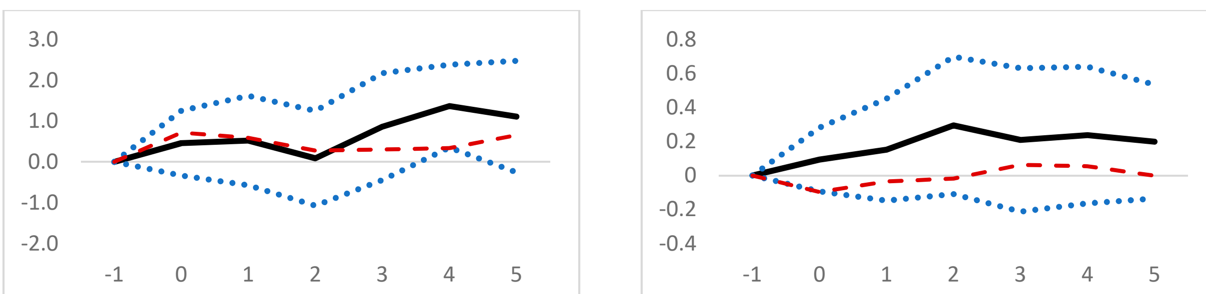
Panel A. Tariff Increases



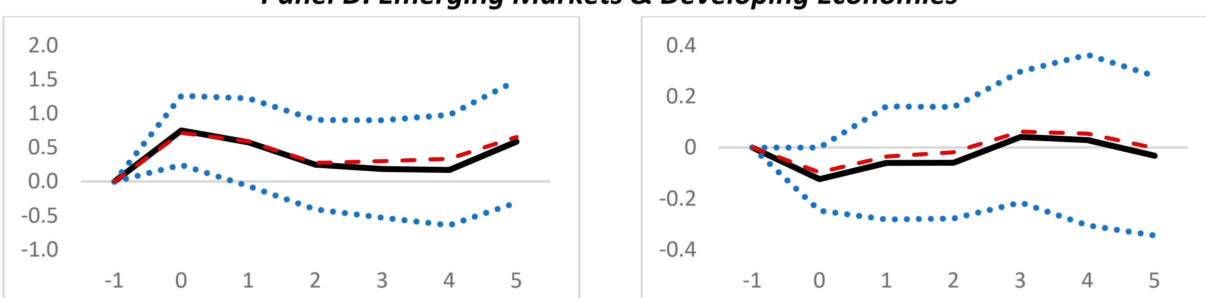
Panel B. Tariff Decreases



Panel C. Advanced Economics



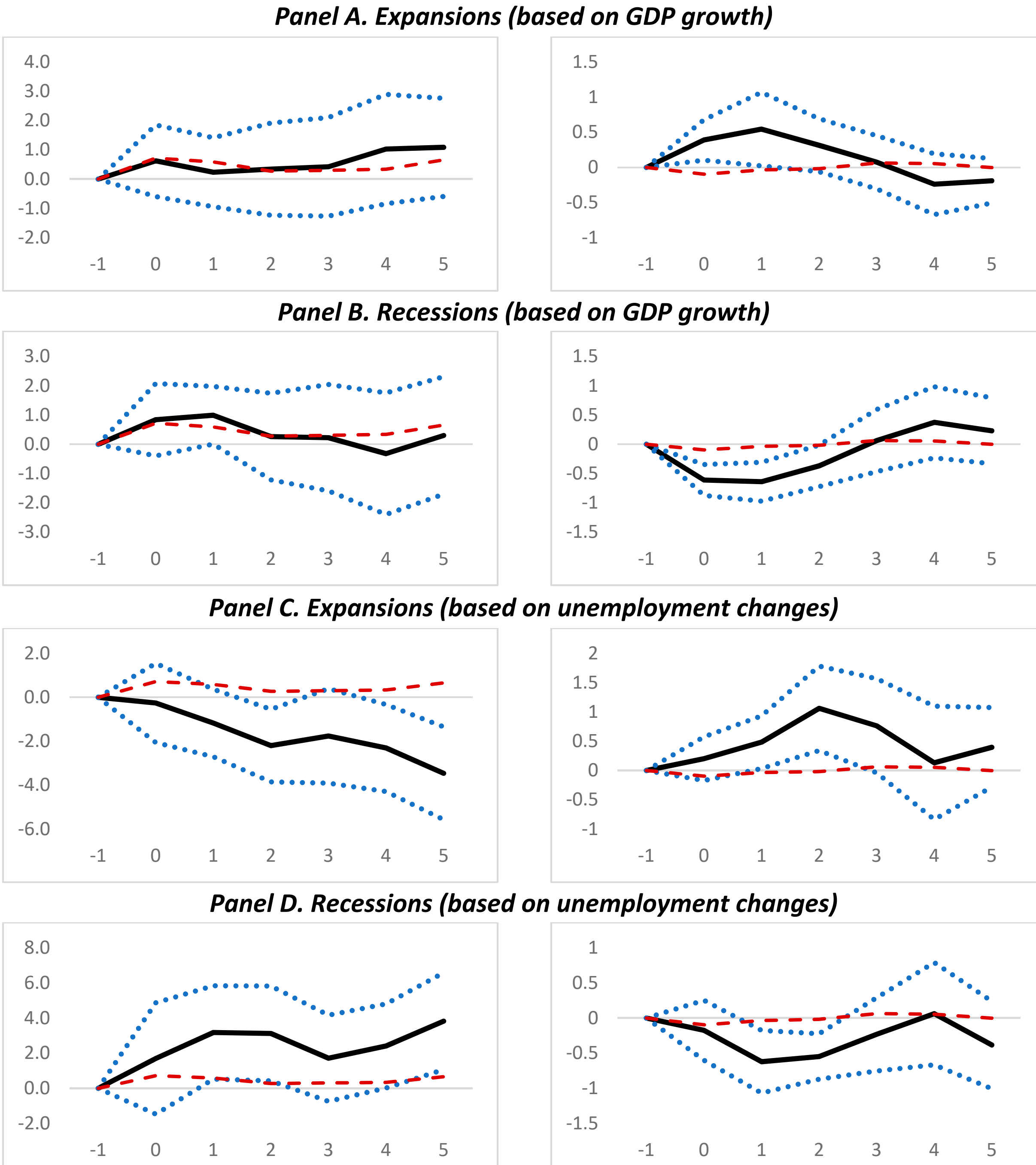
Panel D. Emerging Markets & Developing Economies



Note: The solid black line indicates the response of real exchange rate (trade balance) to a one standard deviation increase and decrease in tariff (advanced economies and emerging markets & developing economies); the dotted lines correspond to 90% confidence bands; estimates for Panel A and B are based on equation (2); estimates for Panel C and D are based on equation (3). Dashed red lines indicate the response of real exchange rate (trade balance) to a one standard deviation increase in tariff in the baseline; estimates based on equation (1). The x-axis denotes time. t=0 is the year of the tariff change.

Figure AI.4. The Effect of Tariffs—Expansions vs. Recessions

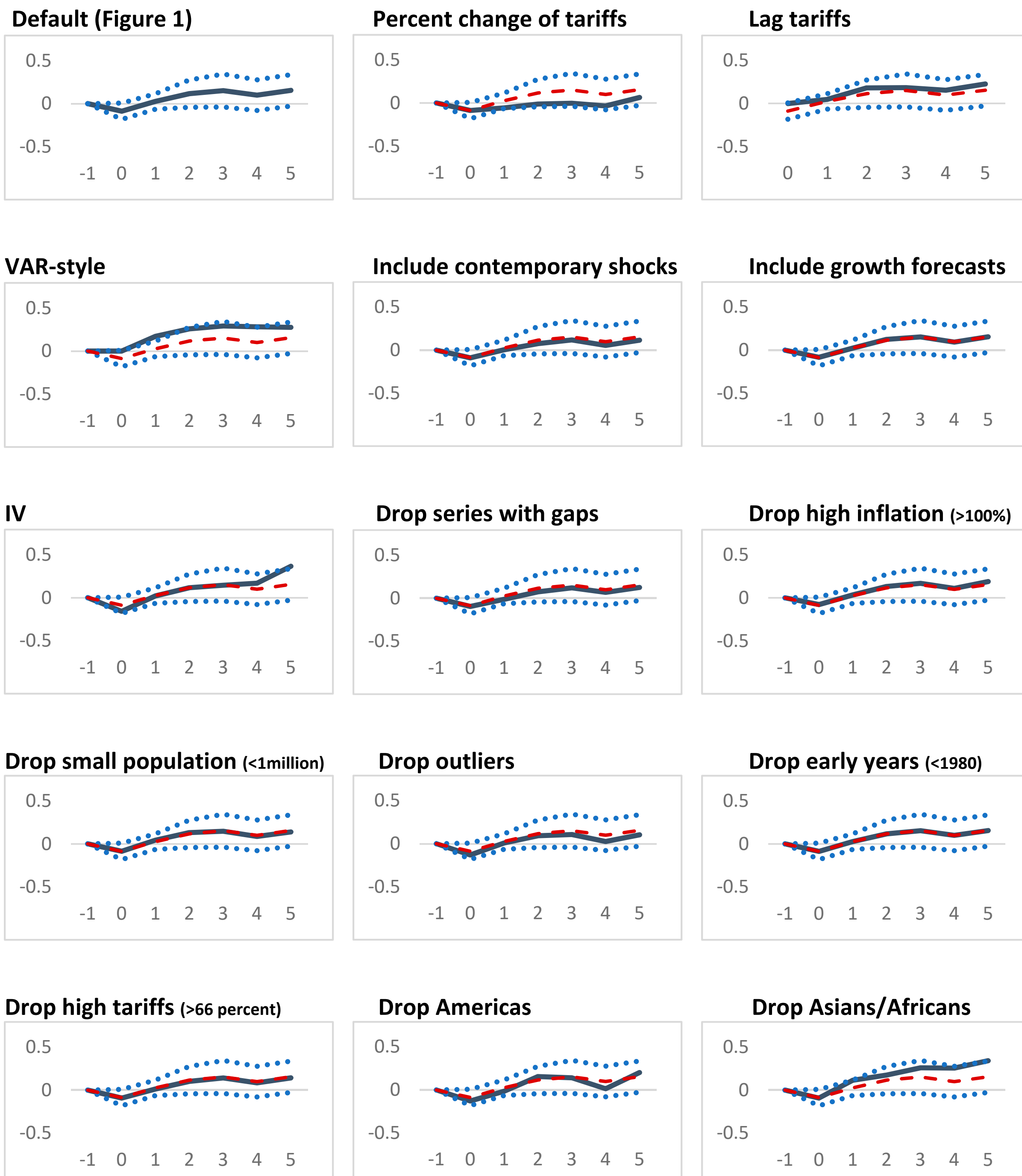
Real exchange rate (%) | *Trade balance-to-GDP ratio (ppt)*



Note: The solid black line indicates the response of real exchange rate (trade balance) to a one standard deviation increase in tariff during expansions and recessions; the dotted lines correspond to 90% confidence bands; estimates based on equation (4); for Panel A and B expansions and recessions are identified using GDP growth; for Panel C and D using unemployment changes. Dashed red lines indicate the response of real exchange rate (trade balance) to a one standard deviation increase in tariff in the baseline; estimates based on equation (1). The x-axis denotes time. t=0 is the year of the tariff change.

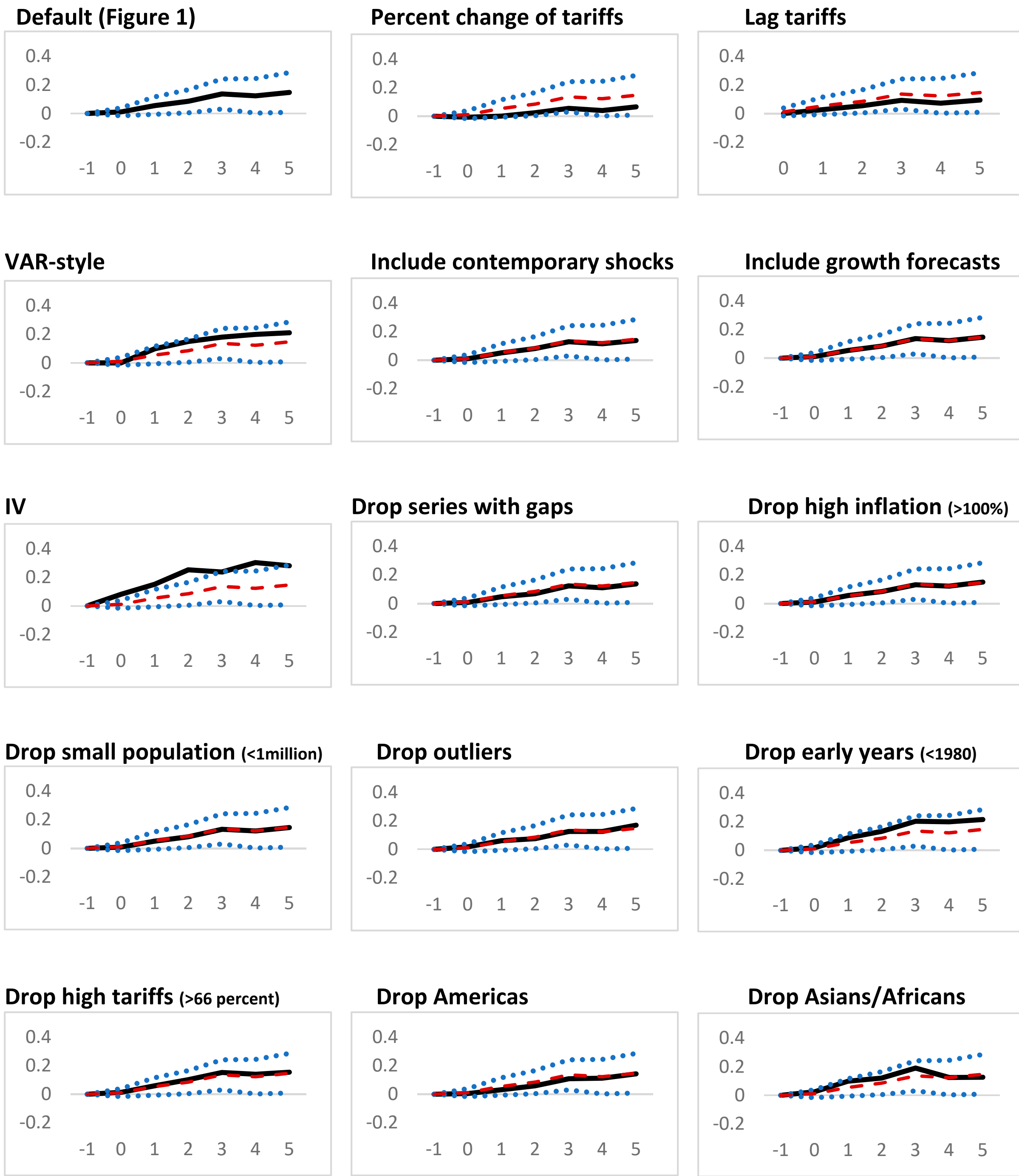
VII. Appendix II—Robustness Results for Unemployment, Inequality, Real exchange rate, and Trade balance

Figure AII.1. Robustness for Unemployment



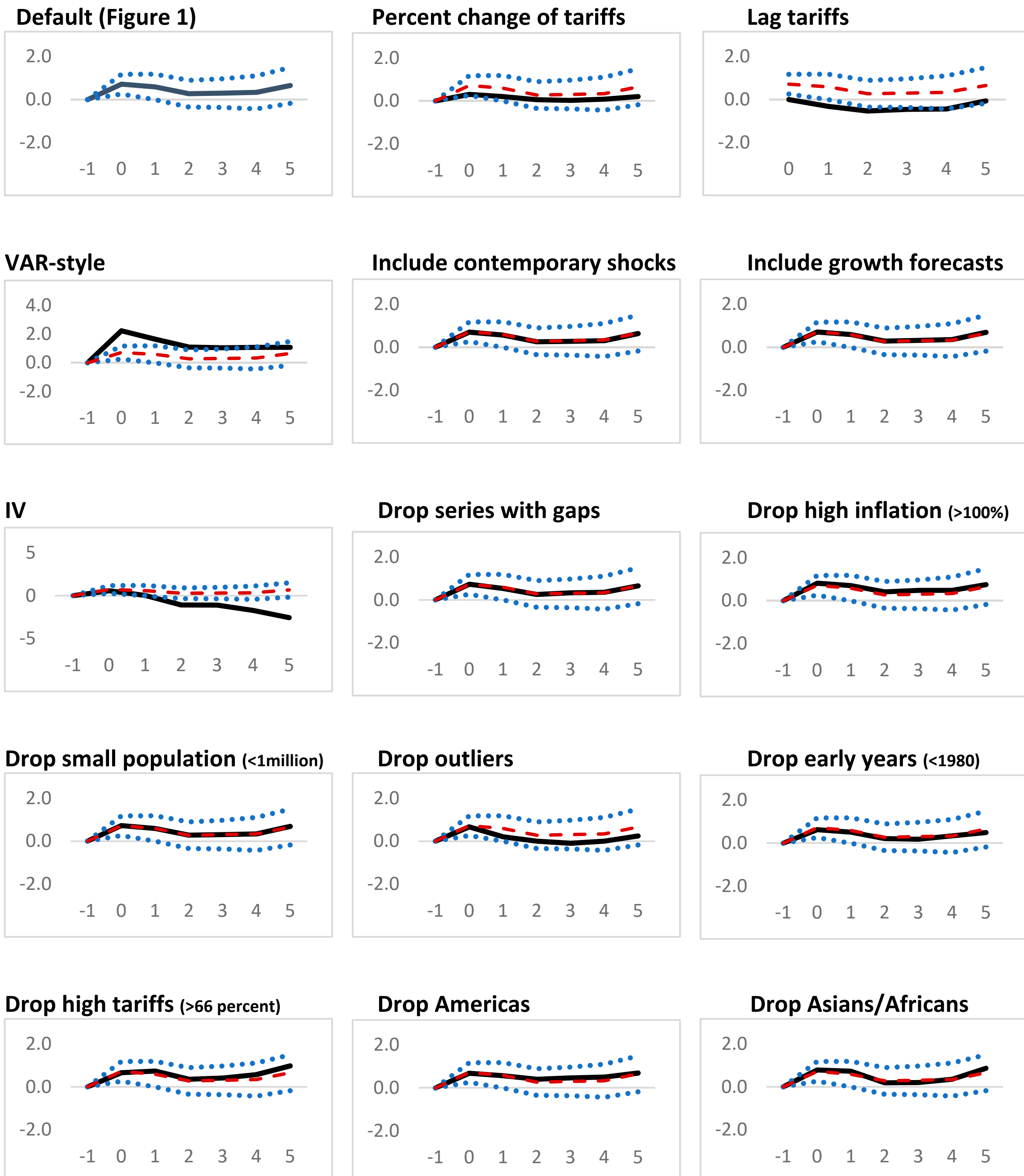
Note: The black solid line indicates the response of unemployment to a one standard deviation increase in tariff using the scenarios described in each title of the chart. The red dotted line represents the baseline results, estimated based on equation (1). The blue dotted lines correspond to 90% confidence bands of the baseline. The x-axis denotes time. t=0 is the year of the change.

Figure AII.2. Robustness for Inequality



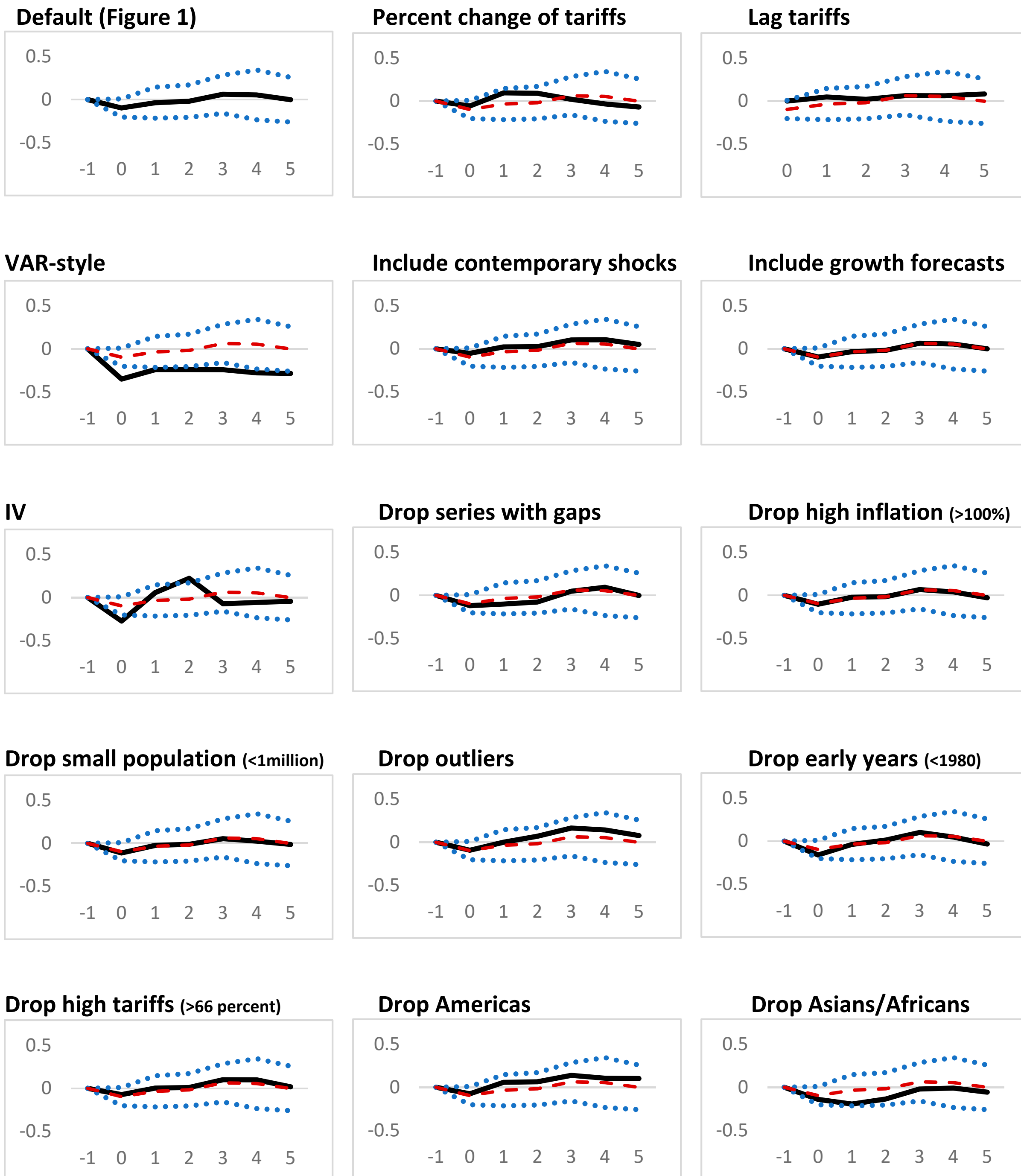
Note: The black solid line indicates the response of inequality to a one standard deviation increase in tariff using the scenarios described in each title of the chart. The red dotted line represents the baseline results, estimated based on equation (1). The blue dotted lines correspond to 90% confidence bands of the baseline. The x-axis denotes time. t=0 is the year of the change.

Figure AII.3. Robustness for Real Exchange Rate



Note: The black solid line indicates the response of real exchange rate to a one standard deviation increase in tariff using the scenarios described in each title of the chart. The red dotted line represents the baseline results, estimated based on equation (1). The blue dotted lines correspond to 90% confidence bands of the baseline. The x-axis denotes time. t=0 is the year of the change.

Figure AII.4. Robustness for Trade Balance-to-GDP Ratio



Note: The black solid line indicates the response of trade balance to a one standard deviation increase in tariff using the scenarios described in each title of the chart. The red dotted line represents the baseline results, estimated based on equation (1). The blue dotted lines correspond to 90% confidence bands of the baseline. The x-axis denotes time. t=0 is the year of the change.

VIII. Appendix III—Instrumental Variable

To address the endogeneity concerns further, we implement an instrumental variable (IV) approach, using as an instrument the weighted-average of changes in the tariff in major (top 5) trading-partner countries, where the weights are determined by the strength of trade linkages with other countries. Specifically, the instrument is computed as follows:

$$I_{i,t} = \sum_{j=1,5\ (j \neq i)} \Delta T_{j,t}\, w_{i,j,t} \tag{A1}$$

where $I_{i,t}$ is the instrument of tariff for country *i* at time t; $\Delta T_{j,t}$ is the change in the tariff for country *j* (up to the 5 largest trading partners) at time t; and $w_{i,j,t}$ is the share of total exports and imports between country i and country j in the total exports and imports for country *i*: $\frac{Export_{i,j,t}+Import_{i,j,t}}{Export_{i,t}+Import_{i,t}}$.

The first and second stage estimates for the output effect suggest that this instrument is "strong" and statistically significant (see Tables AIII.1 and AIII.2). In particular, The Kleibergen–Paap rk Wald F statistic—which is equivalent to the F-effective statistics for non-homoskedastic error in case of one endogenous variable and one instrument (Andrews, Stock and Su, 2018)—for each horizon of the IRF is higher than the associated Stock-Yogo critical values.[21]

In addition, we can plausibly consider the instrument to be exogenous, since changes in the tariff in major (top 5) trading-partner countries are unlikely to be correlated with the error term of Equation (1), once we control for lagged changes in domestic macroeconomic variables (output, real exchange rates, tariff and trade balance). We perform exclusion-restriction tests and find that tariff changes in major trading partners do not have any effect on output or other outcome variables of interest in country i if not through tariff changes in country i. From a theoretical point of view, another concern is that the instrument could be correlated with the error term to the extent that changes in tariff rates in main large trading partners could affect domestic output through contemporaneous changes in the real exchange rate. To address this issue, we modify the equation to control for the contemporaneous changes in other control variables, including the real exchange rates. The results are robust to this specification and very similar to those presented in Figure 5.

Table AIII.1. First Stage estimates of Change in Tariffs on the Instrument (the weighted-average of changes in the tariff in major (top 5) trading-partner countries)

Instrument $_{(t)}$	0.446***
	(3.97)
Change in Tariff $_{(t-1)}$	-0.160**
	(-9.79)
Change in Tariff $_{(t-2)}$	-0.044***
	(-2.82)
Output growth $_{(t-1)}$	-1.400
	(-0.94)
Output growth $_{(t-2)}$	0.585
	(0.40)
Change in REER $_{(t-1)}$	0.001
	90.09)
Change in REER $_{(t-2)}$	0.005
	(0.58)
Change in Trade Balance $_{(t-1)}$	0.332
	(0.64)
Change in Trade Balance $_{(t-2)}$	0.031
	(0.06)
N	3717
R^2	0.08

***,**,denote significance at 1 and 5 percent, respectively.

Table AIII.2. Second Stage estimates of Output on the Change in Tariff Instrumented

	K=0	K=1	K=2	K=3	K=4	K=5
Change in Tariff_Instumented $_{(t-1)}$	0.503*	-0.001	-0.785	-0.770	-1.295**	-1.235**
	(1.78)	(-0.00)	(-1.07)	(-1.29)	(-1.97)	(-1.97)
Change in Tariff $_{(t-1)}$	0.069	-0.044	-0.160	-0.197**	-0.280***	-0.280***
	(1.37)	(-0.60)	(-1.53)	(-2.00)	(-2.45)	(-2.47)
Change in Tariff $_{(t-2)}$	-0.011	-0.036	-0.106***	-0.125***	-0.144***	-0.170***
	(-0.64)	(-1.49)	(-2.71)	(-3.46)	(-4.09)	(-6.74)
Output growth $_{(t-1)}$	0.275***	0.329***	0.351***	0.332***	0.290***	0.277***
	(7.66)	(8.94)	(7.81)	(5.34)	(3.62)	(3.06)
Output growth $_{(t-2)}$	0.005	0.035	0.017	-0.007	-0.026	-0.025
	(0.19)	(0.66)	(0.20)	(-0.07)	(-0.26)	(-0.25)
Change in REER $_{(t-1)}$	-0.028*	-0.069***	-0.099***	-0.080**	-0.038	-0.013
	(-1.82)	(-4.29)	(-4.59)	(-2.27)	(-0.74)	(-0.22)
Change in REER $_{(t-2)}$	-0.027	-0.055*	-0.034	0.010	0.033	0.051
	(-1.39)	(-1.75)	(-0.69)	(0.15)	(0.42)	(0.68)
Change in Trade Balance $_{(t-1)}$	-1.511**	-2.749**	-3.598*	-3.611*	-2.766*	-1.814
	(-2.52)	(-2.43)	(-1.76)	(-1.86)	(-1.75)	(-1.06)
Change in Trade Balance $_{(t-2)}$	-1.001*	-2.298**	-2.221	-1.231	-0.013	1.472
	(-1.84)	(-2.13)	(-1.50)	(-0.61)	(-0.06)	(0.75)
N	3716	3622	3502	3387	3265	3145
KP F-statistics	21.270	24.834	22.737	21.795	25.536	25.297
(Stock-Yogo critical value 10%)	(16.38)	(16.38)	(16.38)	(16.38)	(16.38)	(16.38)

Note: t-statistic based on Driscoll-Kraay standard errors. ***,**,* denote significance at 1, 5 and 10 percent, respectively. Instrument computed as the weighted-average of changes in the tariff in major (top 5) trading-partner countries. Estimates based on equation (1).

Endnotes

[1] For example, see the survey on free trade in Initiative on Global Markets (University of Chicago Booth School of Business): http://www.igmchicago.org/surveys/free-trade.

[2] We also try to account for potential endogeneity via an instrumental variable strategy, using changes in tariffs in major large trading partners to create instruments.

[3] Since the set of control variables includes lags of output growth as well as the real exchange rate and trade balance, this approach is equivalent to a VAR approach in which tariff shocks do not respond to shocks in other variables within a year. We relax this assumption later as a robustness check.

[4] While the original INDSTAT 2 database includes 23 manufacturing industries, exclude the "manufacture of recycling" industry due to insufficient observations.

[5] The average and standard deviation of the change in the tariff rate in our sample are -0.4 and 3.6 percentage points, respectively. Tariff changes range from -52.0 to 41.0 percentage points.

[6] Table 6 tabulates the underlying regression results.

[7] Employment increases by about 0.5 percent but the effect is not statistically significant.

[8] Around 28 percent of our sample observations consist of tariff changes for advanced economies (with a mean of -.3 percentage points and standard deviation of 2.2) and 65 percent of the observations consist of tariff changes for other countries (with mean of -.3 and standard deviation of 4.1). While tariff changes have been less frequent in rich countries, the average magnitude of the changes is similar across the samples. Similarly, we do not observe significantly differences in the ratio of positive-to-negative changes between AEs (65 percent) and non-AEs (75 percent).

[9] This approach is equivalent to the smooth transition autoregressive model developed by Granger and Terävistra (1993). The results are robust different value of θ, and to substitute $F(z_{it})$ with a dummy variable wich takes value for $F(z_{it})$ greater than 0.5.

[10] In line with Rose (2013), we find no statistically significant correlation between changes in tariffs and the measure of state of economy used in the paper. In particular, the correlation between changes in tariffs and the smooth transition function $F(z_{it})$ is -0.001.

[11] See Figures in Appendix I for equivalent results for unemployment, inequality, real exchange rate and trade balance.

[12] In addition to the robustness checks described in detail below, we run a version where the estimations include observations with trade balance between +/-50 percent of GDP given some of the extreme movements in this variable. Our baseline results are robust to this specification.

[13] Analogous results for the other variables of interest (unemployment, inequality, the real exchange rate and the trade balance) are reported in Figures AII, 1-4 of the Appendix; they demonstrate the basic insensitivity of our baseline results.

[14] The results are robust to alternative orderings.

[15] Specifically, we control for contemporaneous changes in the trade balance and real exchange rate for the regressions on output, productivity, unemployment and inequality. For the regression on trade balance (real exchange rate) we control only for simultaneous changes in the real exchange rate (trade balance).

[16] We have also modified equation (1) by allowing all explanatory variables (including changes in the tariff) to enter with a lag.

[17] The Kleibergen–Paap rk Wald F statistic for each horizon of the IRF is always higher than the associated Stock-Yogo critical values.

[18] From a theoretical point of view, another concern is that the instrument could be correlated with the error term to the extent that changes in tariff rates in main large trading partners could affect domestic output through contemporaneous changes in the real exchange rate. To address this issue, we modify the equation to control for the contemporaneous changes in other control variables, including the real exchange rates. The results are robust to this specification and very similar to those presented in Figure 5.

[19] Similar results are obtained when top and bottom 5th percentiles of the same distribution are considered.

[20] The result that input tariffs have a more detrimental output effect than output tariffs is consistent with previous empirical work examining the effect of input and output tariffs at the macro (e.g, Ahn et al. 2016) and at the firm level (e.g. Amiti and Konings 2007).

[21] Similar results are also obtained for productivity.